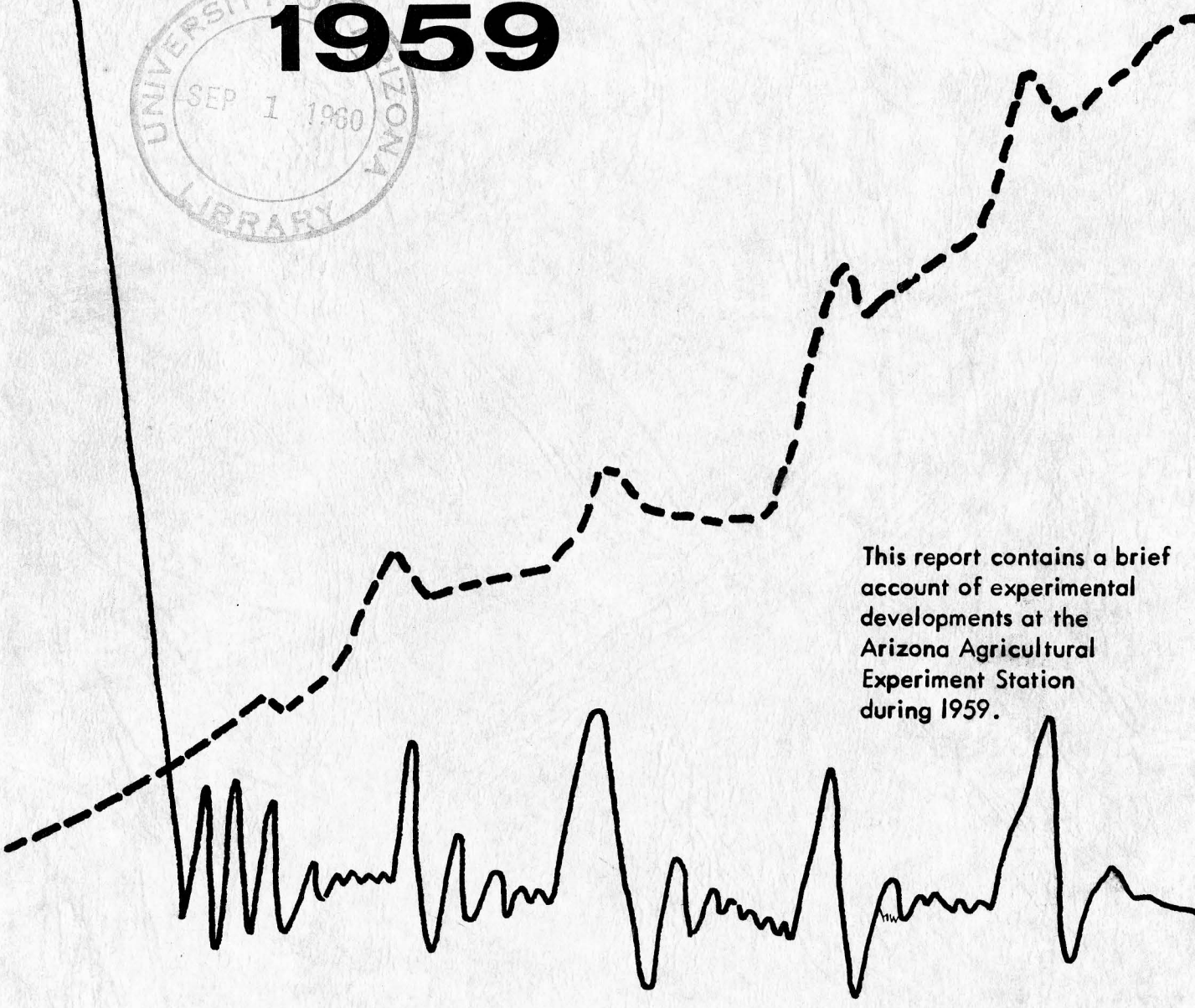
Report 190

RESEARCH PROGRESS

1959



This report contains a brief account of experimental developments at the Arizona Agricultural Experiment Station during 1959.

AGRICULTURAL EXPERIMENT STATION

THE UNIVERSITY OF ARIZONA

Tucson

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This publication is prepared primarily for the internal use of the College of Agriculture, The University of Arizona, and for those individuals and institutions particularly concerned with the progress of research at the Agricultural Experiment Station for the period between January 1 and December 31, 1959.

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Department of
AGRICULTURAL BIOCHEMISTRY

1. PHYSIOLOGICAL AVAILABILITY OF AMINO ACIDS AND OTHER NUTRIENTS IN FEEDS.

Project Number: 258-A. Funds: Hatch and State. Personnel: M. G. Vavich, A. R. Kemmerer, A. A. Kurnick, and B. W. Heywang. (In cooperation with Poultry Science Department; Southwest Poultry Experiment Station)

Work was begun on a comparison of the vitamin A requirement of growing chicks in hot weather and cold weather in two locations in Arizona. A complete diet varying only in vitamin A content was fed for eight weeks following a preliminary depletion period of 1 or 2 weeks. A commercially available source of stabilized vitamin A was used as the sole source of vitamin A.

Gain in weight and liver storage of vitamin A are to be used as criteria. To date one summer and one winter experiment has been completed. Both locations gave essentially the same results relative to treatment in the summer trial. The data will be treated statistically when the second year's study is completed. From the results so far, it appears that 1500 units of vitamin A per pound of feed is adequate for growing chicks for both winter and summer in Arizona.

2. THE NUTRITIVE VALUES OF SOUTHWESTERN PRODUCED FEEDS AND FACTORS AFFECTING THESE NUTRITIVE VALUES.

Project Number: 258-C. Funds: Hatch and State. Personnel: M. G. Vavich, A. R. Kemmerer, W. F. McCaughey, D. L. Schneider, M. R. Smith, W. S. Fleming, B. W. Heywang, A. A. Kurnick, and Harold Nordby. (In cooperation with Southwest Poultry Experiment Station; Poultry Science.)

When seven honeys were tested for biological factors, citrus and sweet clover were found to contain a growth-promoting factor for Saccharomyces cerviseae. Sweet clover honey in 5% solution promoted rooting of chrysanthemum cuttings, but to a lesser extent than the control solution. Weight gains of rats fed two of the honeys were significantly greater than those fed a comparable sucrose diet. Carcass analysis is currently underway to determine whether these gains represented fat or protein.

The causative agent in cottonseed oil which causes pink discoloration of eggs was concentrated 16 times. This compound has been isolated by paper chromatography and has an R_f value slightly less than sterculic acid.

Sterculic acid fed as Sterculia foetida oil to growing rats increased liver weight by increasing the fat content. Total solids and protein of the liver were not changed. Carcass solids, fat, protein and ash content were not affected. The size of the kidneys and adrenals were not affected. Hatchability of eggs was impaired by feeding 0.15 g. Sterculia foetida oil daily to laying hens. Embryos failed to develop beyond the fifth day. Eggs layed seven days or longer following withdrawal of the Sterculia foetida oil supplement hatched normally.

3. THE INFLUENCE OF THE INTERRELATIONSHIP OF FOOD FACTORS UPON PHYSIOLOGICAL UTILIZATION OF CAROTENE AND VITAMIN A.

Project Number: 271. Funds: Hatch and State. Personnel: A. R. Kemmerer, M. G. Vavich, and Wm. H. Bowles.

Hydrocortisone acetate decreased significantly the utilization of carotene for liver and kidney storage of vitamin A in both male and female rats. Hydrocortisone reduced by 30% the utilization of vitamin A per se in female rats but only slightly in male rats.

Insulin reduced the utilization of carotene for liver and kidney storage of vitamin A approximately 50% in male rats and approximately 20% in female rats. Insulin and cortisone administered together did not counteract or implement the effect of the other. This was contradictive to what had been expected.

4. POLLEN SUBSTITUTE FOR HONEYBEES.

Project Number: 382. Funds: Hatch and State. Personnel: A. R. Kemmerer, W. F. McCaughey, F. E. Todd, S. E. McGregor, and L. N. Standifer. (In cooperation with Bee Culture Laboratory, Entomology Research Division, U.S.D.A.)

Amino acid analyses of nine pollens and eight protein substances showed the presence of pollen amino acids generally in sufficient amounts for bees, with possible exception of threonine and valine. Several of the protein sources were deficient in the indispensable amino acids isoleucine, leucine, lysine, methionine and threonine. Supplementation of two of these proteins, sesame seed meal and soy hydrolysate, with pure amino acids for these deficiencies failed to produce a significant growth response over that obtained with the unsupplemented proteins. Fecal nitrogen excretion of caged bees fed pollens or protein sources showed an inverse relationship with pharyngeal gland development, a criterion of diet adequacy. Pollen gave better gland growth and lower nitrogen values. Higher nitrogen excretion was observed with 10% pollen in the diet than with 5%. To determine the pattern of nitrogen excretion of the honeybee, analyses are currently underway for total nitrogen, uric acid, alpha-amino nitrogen, urea, creatine, creatinine and ammonia in the fecal material from caged bees fed pollen, egg albumin, soy hydrolysate, or casein diets. Highest total nitrogen has been found for the soy diet and lower values for pollen and casein, indicating better utilization of the latter two diets. Pollen and egg albumin yielded the lowest uric acid excretion with soy again showing the greatest value. Paper electrophoresis of some pollen proteins has showed only single albumin and globulin fractions. Five percent of protein was shown to be optimum in diets for caged bees.

5. THE RELATIONSHIP OF FAT BULK AND OTHER CONSTITUENTS OF THE DIET TO BLOOD CHOLESTEROL.

Project Number: 410 (Regional W-44). Funds: State Research. Personnel: A. R. Kemmerer, A. A. Kurnick, M. G. Vavich, and D. L. Schneider. (In cooperation with Poultry Science Department.)

This year's study was conducted in an effort to develop a technique of consistently producing cholesterol plaques in the aorta of the male chick.

One hundred sixty, eight-week-old cockerels were placed on a practical basal diet containing 3% Crisco and with or without 1% cholesterol. Nothing substantial developed throughout the first 40 weeks of the experiment. During this period neither raising the Crisco level to 5% nor changing the basal to a synthetic diet altered the situation.

At 40 weeks changes were made in the diets and the birds were examined at the 50th week. Those receiving 5% or 10% Crisco had only slight plaque formation which for the most part involved the abdominal aorta. Fewer birds were affected on the 10% Crisco than on the 5% Crisco, however, plaque involvement was considerably greater. All of twelve birds receiving 5% Crisco and 2% cholesterol developed plaques with the abdominal aorta having the most involvement. Four birds had involvement of the total aorta. All eleven birds receiving 10% Crisco and 1% cholesterol developed plaques with the total aorta being involved in six of the birds.

6. CROSS-LINKING OF COTTON TO PRODUCE A WASH-AND-WEAR TYPE OF FABRIC.

Project Number: 453. Funds: State. Personnel: Archie J. Deutschman, Jr. and Henry W. Kircher.

Work is continued on vinylation of carbohydrates. The reactions continue to look promising in a number of polymer applications. The work is directed toward the production of new plastics from agricultural products and the improvement of wrinkle-resistant cotton textiles. Cottonseed oil has been successfully treated to remove factors causing pink egg discoloration when fed to laying hens.

7. AMINO ACID PROPORTIONS AND BIOLOGICAL UTILIZATION OF PROTEINS IN SORGHUM GRAINS.

Project Number: 464 (W-57). Funds: Regional Research and State. Personnel: M. G. Vavich, A. R. Kemmerer, and B. W. Heywang. (In cooperation with Southwest Poultry Experiment Station.)

A comparison was made of weight gains and efficiency of feed utilization for corn and five commercially available sorghum grains. The diet was adapted from the N.R.C. Reference Chick Diet. The diet contained 63 1/2% corn or an equivalent amount of sorghum grain. Groups of 20 chicks were replicated four times and were fed for 6 weeks in battery brooders. Final average weights in grams were as follows: Corn 801, Early Hegari 695, Hybrid Milo 782, Martin Milo 800, Caprock Milo 809, and Double Dwarf Milo 758.

In addition to matching the growth made on corn the Martin Milo and Caprock Milo showed equally good efficiency of feed utilization as corn.

8. TISSUE CULTURE INVESTIGATION IN RHEUMATOID ARTHRITIS.

Project Number: A-2520 (C-1). Funds: U. S. Public Health Service. Personnel: A. B. Stanfield, R. A. Hartline, and M. E. Crawford. (In cooperation with Southwestern Clinic and Research Institute, Inc.)

Investigations have continued on the morphological and cultural behavior of cells from synovial membranes and fluids. Cells have been cultured from the synovia of 42 patients with rheumatoid arthritis and from 70 non-rheumatoid

patients. 15 synovial fluids have also been cultured. Records include paraffin sections on all tissues as well as permanent stains of the cultured cells. More than 1500 photomicrographs and 10,000 feet of movie film have been taken for study and record. Cultured cells have been challenged with rheumatoid sera, bursae and splenic breia, synovial fluids, buffy coat material, bacterial antigens and various media. Rheumatoid cells from one culture have been in continuous propagation for 11 1/2 months. Ease of transfer in various media and culture on glass show characteristics of possible strain. Two possible strains of non-rheumatoid cells have been continuously transferred for over 6 months.

Our concept of R.A. is that of a delayed hypersensitivity state occurring at the cellular level. To demonstrate possible cytopathological effects we have set up a model system. Experimental arthritis has been induced in rats according to the technic of Dr. Carl M. Pearson, and cells have been cultured from the rat synovia.

Department of
AGRICULTURAL CHEMISTRY AND SOILS

1. WEATHER (IN COOPERATION WITH THE U. S. WEATHER BUREAU).

Project Number: 160. Funds: State. Personnel: H. V. Smith.

Weather observations have been made this year with the cooperation of the U. S. Weather Bureau, much as they have been in the immediate past. The year, as a whole, was warmer and more moist than the average.

Thermograph observations in the Catalina Foothills have been discontinued but the results have not yet been tabulated.

Smith, H. V., When It Comes to Climate Arizona Has Everything, Progressive Agriculture, Winter, 1960.

2. NUTRITIONAL, CHEMICAL AND PHYSICAL STUDIES ON THE MORE IMPORTANT SOIL TYPES IN ARIZONA.

Project Number: 265. Funds: Hatch and State. Personnel: R. R. Binnie, G. E. Draper, and H. V. Smith.

Correlation samples were collected from the Beaver Creek Soil Survey Area, a project initiated by the U. S. Forest Service in cooperation with the Soil Conservation Service and the Department of Agricultural Chemistry and Soils. Many of these have already been tested in the laboratory.

Studies are now in progress to determine factors in soils which may affect their gypsum requirement and to determine broad groups of soils having no gypsum requirement, or a low, medium or high gypsum requirement.

Another study which is underway at present is one involving the nitrogen supplying power of soils. The method was developed in Iowa and has been used to measure the amount of nitrogen a given soil can supply from its organic content. The method requires that the soils under test be leached free of nitrate, allowed to incubate for two weeks and the nitrate content of the incubated soil determined.

3. FERTILITY REQUIREMENTS OF CROPS ON ALKALINE - CALCAREOUS SOILS OF DIFFERENT TYPES, UNDER SEMIARID AND IRRIGATED CONDITIONS.

Project Number: 266. Funds: Hatch and State. Personnel: T. C. Tucker, Fred Turner, H. F. Kreizinger, and J. L. Abbott.

Cotton: Eleven experiments conducted with yield responses to N at rates of 50-200 lbs. N/A. No response to P. Nitrogen did not influence yield at one location and decreased yields at another site. Nitrogen sources were equally effective when applied as a June sidedress treatment. Preirrigation application was inferior to sidedress application especially with nitrate sources. A study of timing of N application resulted in valuable basic information on nitrate-N in cotton petioles in relation to flowering, boll set, vegetative characteristics and yield. Grain Sorghum and Corn: Eight experiments with yield responses to 50-150 lbs. N/A. Corn ensilage yields increased by N-P interaction. Alfalfa:

No response. Safflower: Response to N rates as high as 150 lbs. N/A. Timothy: Response to N. Irrigated Pasture (Mixed grasses) nitrogen - P interaction. Wheat and Barley: Four experiments with results varying from yield reductions from N to large yield increases resulting from N-P interactions. Factors contributing to yield were influenced greatly by N-P interaction. The dominant effect was in increased tillering. The tissue testing phase of the program was expanded with cotton and grain sorghum. Lettuce: (supported in part by TVA) Compared various sources of N and P and times of application. Broadcasted ordinary superphosphate and sidedressed ammonium nitrate were best in Harquahala Plains. At Tucson, adding Mg increased yields. K and high N did not. Tomatoes: Tested various sources of Fe vs "Curly-top" disease. At Tucson, Sequestrene 138 Fe helped plants to better survive infection. At Yuma, all sources decreased yields, but did not affect survival of plants. Cantaloupes: At Yuma, showed no decrease in crown blight where Fe, K, Mg and high N were added to the soil. Potatoes: Commercial mix with K, S and blood meal gave no higher yields than did 13 other combinations of N, P and trace elements. 50' plots and 100' plots were statistically no different in reliability for tests. Citrus: N, P and trace elements applications at Tempe and Yuma continued with no differences in yields the 1st and 2nd years. Manure Sources: Significant increases in cotton yields four years after applications of either composted or uncomposted bovine manures.

Third Annual Arizona Fertilization Conference Report - 1959. The Effect of N and P on the Composition and Factors Affecting Wheat Yields. Presented SSSA Meetings, November 20, 1959. (in press).

4. THE AVAILABILITY OF NATIVE SOIL PHOSPHATE AND NEW COMMERCIAL PHOSPHATE FERTILIZERS IN ARIZONA CALCAREOUS SOILS.

Project Number: 280. Funds: Hatch, State, and California Spray Chemical Corp. Personnel: W. H. Fuller, T. C. Tucker, and J. L. Abbott.

Phosphate fertilizers of varying water solubility and two particle sizes were studied in the field with grain sorghum and barley. A phosphorus yield response did not result in either experiment. Three field experiments were conducted on cotton with various commercial and TVA fertilizer materials. Yields were not affected. Tomato plants were used as a test crop in the greenhouse to measure the solubility-particle size effects on three different soils. Both yield of tomato tops and total P uptake were criteria of evaluation. Results indicated particle size was not important with a Gila and Tucson soil. Increasing water solubility increased yields and uptake in these cases. Particle size was as important as water solubility in the Karro soil. Dicalcium phosphate of small particle size behaved as the more soluble materials. Some chemical methods were studied for the evaluation of "available" soil phosphorus.

An experiment has been started to expand the objectives of this project and give us supplemental information on the movement of phosphorus in three soils (Superstition fine sand; Superstition fine sand, silted phase; and Gila silt loam).

Third Annual Report on Soil Fertility and Fertilizer Research. Jan. 1960. Ariz. Agric. Exp. Sta. and Agri. Ext. Ser.

Jones, J. P., Chemical Methods for Evaluating Available Phosphorus in Arizona Soils: M. S. Thesis, 1959.

C. O. Stanberry, W. H. Fuller and N. R. Crawford, Comparison of Phosphate Sources for Alfalfa on a Calcareous Soil (in press). Ariz. Tech. Paper #548.

C. O. Stanberry, Advantages and Disadvantages of Various Methods of Applying Commercial Fertilizers in Neutral and Alkaline Soils of Western States. Published by the Bureau of Reclamation, November 1959 in the Reclamation Era.

5. THE NATURE OF MICROFLORA AND THEIR ACTIVITY IN ARIZONA SOILS AS AFFECTED BY SOIL TEMPERATURE, MOISTURE, SALINITY, pH, AND OTHER FACTORS PECULIAR TO SEMI-ARID CONDITIONS.

Project Number: 283. Funds: Hatch and State. Personnel: W. H. Fuller

Research designed to study the factors that influenced the mineralization or rate of release of phosphorus from different crop residues and the availability of phosphorus from such residues for succeeding crops was continued only on a limited basis. There is some doubt that crop residues make unavailable native soil phosphorus available to succeeding crops in appreciable quantities as once believed. The influence of crop residues on the phosphorus status of succeeding crops is principally due to supplying phosphorus directly as a result of microbiological attack of the residue.

As part of the overall objective to determine the effect of crop residues on the rate of release plant nutrients from less available soil forms for plant use, particular attention was focused on calcium. By use of radiocalcium, it was shown that small amounts of certain crop residues do not affect the availability to plants of calcium from free-calcium carbonate of the soil. Quantities of crop residues in excess of 10 tons of dry matter per acre do influence the solubility of calcium carbonate in soils.

Some attention was given to the methods of culturing soil algae under laboratory conditions for the study of nitrogen fixation. A manuscript was prepared on soil algae of the desert area and presented for publication.

Cameron, R. E. and Fuller, W. H., Fixation of Nitrogen by Algae of Arid Soils, Proc. Am. Soc. Soil Sci. 1959, (in press).
Fuller, W. H., McAlister, D. F., and Metcalfe, D. M., Advances in Agronomy Monograph, 1959, (in press).
Fuller, W. H., Soil Resources of Arizona, Arizona 1959. (in press).

6. A STUDY OF THE EFFECT OF TEMPERATURE VARIATION ON VARIOUS CHEMICAL AND PHYSICAL SOIL PROPERTIES WHICH AFFECT FERTILITY.

Project Number: 289. Funds: Hatch and State. Personnel: R. H. Maier and J. S. Bullock.

Mimbres loam and Laveen loam was held at 5°, 25°, and 45°C, at constant soil moisture content, for two weeks. Soil treatments consisted of 0 and 100 lbs/A. P_2O_5 from three phosphate source materials, e.g. - two nitric phosphates and one TVA phosphate. Complete soil chemical data for Mimbres loam were presented in the report of last year. There was no increase in ammonium-acetate soluble phosphorus in Laveen loam as a function of soil treatment or increase in soil temperature. The ammonium-acetate soluble iron in Laveen loam decreased from 5°C to 45°C but showed a slight increase from 5°C to 25°C. This is opposite to the extractable soil iron from Mimbres loam with increases in soil temperature. Fractionation of soil iron in Mimbres loam has shown that there are large quantities of iron in the ammonium hydroxide fraction (organic fraction) as compared to the Laveen soil. Laveen loam showed the largest amount of soil iron in the acid-soluble fraction (0.1 N hydrochloric acid). Varying soil temperatures in Laveen loam had no

influence on ammonium-acetate soluble calcium or potassium, and organic carbon content. A recording soil thermograph is being used to record soil temperatures at 3, 6, 18, and 48 inch depths in a Gila soil which has a bare surface. As expected, the shallow depths warm more rapidly in the spring, reach a higher temperature in the summer, and cool faster in the fall, than does the soil at deeper depths. There is essentially no diurnal variation in soil temperature at the 18 and 48 inch depths.

Bullock, J. S. and Maier, R. H., Chelometric Titration of Calcium Using a Mixed Indicator, Anal. Chim. Acta 20:419-422, 1959.

Maier, R. H., A New Sensitive Indicator for Semi-Micro Chelometric Titrations, Nature 183: 461-462, 1959.

7. SOIL SURVEY (IN COOPERATION WITH SOIL CONSERVATION SERVICE).

Project Number: 326. Funds: State. Personnel: R. R. Binnie.

Made a detailed inspection of soils on the Experiment Farm at Safford and recorded textures to a depth of 60 inches at 214 sites.

Participated in the initial review of the survey in the Whitewater Draw Soil Conservation District (Cochise Co.) with SCS officials.

Participated in the progress review of the survey in the Beaver Creek Area (Yavapai-Coconino Counties) with SCS and Forest Service officials.

Participated in the progress review of the surveys in Pima and Santa Cruz Counties with SCS officials.

Participated in examination of range and forest soils on the Ft. Apache Indian Reservation with SCS and Bureau of Indian Affairs officials.

Participated in the work of two committees at the Western Regional Technical Work Planning Conference for Soil Survey.

Participated with SCS officials in work toward the preparation of a soil association map of Arizona.

8. THE INFLUENCE OF BED SHAPE, PLANTING, AND IRRIGATION PRACTICES ON THE GERMINATION AND YIELD OF CROPS ON SALINE SOIL.

Project Number: 409. Funds: Hatch and State. Personnel: Fred Turner, Jr., A. A. Baltensperger, and L. C. Chapman.

Research continued on investigating the effects of low salt (river) and high-salt (well) waters in various combinations for leaching and irrigating, on the germination, growth and yields of crops grown on a saline-alkali soil. In 1956 and 1957, cotton yields on these plots were highest where river water was used for leaching. In 1958, the yields were highest where only well water was used. In two trials in 1959, cotton germinated and survived best where only river water was used for leaching. Higher soil temperatures favored germination. Yields from cotton planted on four bed shapes were nearly the same. Where the seeds were planted in the bottom of the furrow, germination and survival of plants was practically nil. Three varieties of Bermuda grass were planted in flat borders in late summer. Survival of these plants in this saline-alkali soil will be determined.

The effects of various levels of applied nitrogen on growth of the plants and on soil conditions will be measured.

The above experiments are all being conducted at the Branch Station, Safford, Arizona.

9. BASIC PRINCIPLES INVOLVED IN TRACE ELEMENT NUTRITION OF CROPS AND AVAILABILITY IN CALCAREOUS SOILS.

Project Number: 441. Funds: Hatch and State. Personnel: R. H. Maier

Five micronutrient source materials were evaluated on four soils with respect to micronutrient extraction from soils with ammonium acetate and nitric acid and plant uptake and growth. The micronutrients studied in this manner were iron, copper and zinc. The source materials were granules, polyamino carboxylic acid, chelates, frits, sulfates, and a polyhydric sugar-like chelate (Marathon). The soils used were Superstition sand, Adelanto loam, Laveen loam, and Gila very fine sandy loam. Tomato, var. Early Pack, was the test plant. There was an increase in vegetative yield (dry weight) compared to the no micronutrient treatment for the micronutrients contained in the granule, chelate, frit, and Marathon source materials in Superstition sand. In the Adelanto soil, maximum vegetative yield was obtained from the sulfate treatment while there was no growth response for added micronutrients in the Laveen or Gila soil. Where growth responses to micronutrients were observed, the stimulation of growth was apparent at the early stages of plant development. The extraction data of iron,copper, and zinc from the four soils under six treatments were not consistent. Previous work has shown that soils differ widely in their ability to release certain forms of micronutrients to chemical extracting agents. In general, plants growing in soils treated with the polyamino carboxylic acid chelates had the greatest uptake of micronutrients. There was no lucid relationship between plant growth or micronutrient uptake and amount of micronutrients extracted from the soil.

10. FIXATION OF NITROGEN IN SEMIARID SOILS.

Project Number: 443 (W-31). Funds: Regional Research and State. Personnel: Nicholas Raica.

Sandy loam soil was potted and inoculated with algae crust or laboratory culture of Nostoc. Pots were incubated for eight weeks with various water treatments and then planted in rye grass. Algae inoculated soil--gave better yields when incubated with alternating wet and dry cycles, did not improve growth or increase nitrogen uptake over non-inoculated soil. Non-inoculated soil gave better yield with dry incubation. Wet incubation gave poorest yields. Moisture loss was reflected more by yields than algae inoculation or crust development. Non-inoculated pots gave better yields than inoculated pots. Culture conditions such as media and pH, for good growth of algae on an illuminated shaker were not the same as those required in stationary flasks. Growth of algae was greatly accelerated on the shaker. Nostoc cultures had as much as 50% of the "total growth" and 30% of its nitrogen in the extracellular medium. Washed, autoclaved algae when added to sand cultures of barley or rye result in an increased uptake of nitrogen by the seedlings and an increase in yield. A species of Protococcus which turned an orange brown in nitrogen deficient media was found to contain as much as 4,000 ppm xanthophyll. Generally the xanthophyll in young semi-orange cultures is about 2700 ppm. As brown color develops there is a loss of chlorophyll with an increase in total carotenoid but carotene fraction increases more rapidly than the xanthophyll fraction - X/C - 7 - 4. The Myakins micro-method for soil Kjeldahl nitrogens is being evaluated.

11. SOIL AND WATER TESTING (IN COOPERATION WITH THE AGRICULTURAL EXTENSION SERVICE).

Project Number: 455. Funds: State. Personnel: H. V. Smith, G. E. Draper, and H. Corrie.

As an accommodation to the farmers and gardeners of the state, the Department of Agricultural Chemistry and Soils has maintained a laboratory service where soils and waters were tested without charge. During the year of 1959, 1,381 soil and 1,237 water samples were tested under this program.

The department analyzed 589 samples of soil and 82 waters for the Soil Conservation Service. This laboratory information aids the soil surveyors to classify certain soils properly.

As time permits laboratory methods are examined and changes made if a superior method can be found. For example Methyl Purple has been substituted for methyl Orange indicator for bicarbonates in water. Likewise Calgon has been substituted for laboratory prepared sodium hexametaphosphate as a dispersing agent for soils being prepared for mechanical analysis. The sodium status of soils and waters are being appraised by methods published by the U. S. Regional Laboratory. These changes in methods of analysis are being incorporated in the laboratory's loose-leaf book of methods.

The Sulfate determination is more reliable when made by the barium chloride-gum arabic procedure than by any method previously used.

The laboratory was host to the Agricultural class from the Eastern Arizona Junior College, Thatcher, which was given lectures on soil and water testing. During the year seven foreign visitors were instructed in methods used in our laboratory. Some spent a few hours, some a few days, and one came in periodically for three months.

12. WATER AND ION MOVEMENT IN SOILS AND PLANTS.

Project Number: 472. Funds: State. Personnel: D. M. Anderson, R. H. Maier, and C. O. Stanberry.

Construction of an apparatus for the study of liquid and vapor movement in soils, which was begun last year, was completed and tested. It was then used successfully to distinguish liquid from vapor flow in soil by analyzing the temperature fluctuations occurring near the wetting front. It was found that the temperature fluctuations accompanying the movement of a wetting front were caused by the evaporation from the wetting front, condensation of water vapor on the medium, and the heat released by wetting the medium.

After irrigation and the establishment of the so-called "field capacity," plants obtain the water essential for growth and transpiration by two mechanisms. Either the water moves to the plant by unsaturated flow or the roots elongate to provide new absorbing surfaces in the soil area where water exists.

The apparatus for unsaturated flow has been completed and the materials accumulated to permit the evaluation in soils of different textures on the relative importance of unsaturated flow and root extension in water uptake.

A separate investigation relates the moisture content of soils and nutrient uptake between "field capacity" and the "permanent wilting percentage." A root study is being initiated to relate topgrowth and root activity "moisture absorption." The equipment has been developed and four crops are being planted on three soil series.

Temperature Fluctuations Accompanying Water Movement through Porous Media. (in press).

13. MECHANISMS OF SOIL AGGREGATION AND DISPERSION.

Project Number: 487 (W-66). Funds: Regional Research and State. Personnel: D. M. Anderson.

A silicon to oxygen bonding of $Mo_3SiCl_{(g)}$ and of $C_{18}H_{37}SiCl_3$ to soil minerals was attempted utilizing vacuum technique. Presumptive evidence that the bond was accomplished has been obtained.

Volume changes accompanying the sol-gel-sol transformation of a thixotropic bentonite suspension were observed. In suspensions which contained dissolved and adsorbed air relatively large, irreversible volume changes were observed. In suspensions containing no air, the volume changes were observed to be small but were reversible.

14. A STUDY OF THE MECHANICS OF UNSATURATED FLOW OF WATER IN SOILS.

Project Number: 488 (W-68). Funds: Regional Research and State. Personnel: D. M. Anderson.

A thermostat air chamber capable of controlling temperature within $\pm$ 0.001°C was constructed. The chamber is still undergoing tests but also is being used to study water flow in soils.

Temperature fluctuations accompanying a moving, wetting front were discovered. Extensive tests have shown this phenomena in all soil textures and even in spherical glass beads. The maximum fluctuations were observed in Wyoming bentonite and were of the order of 10°C. The smallest fluctuations occurred in glass beads and were observed to be about 0.1°C.

Extensive collection of research papers dealing with unsaturated flow of water in soils was begun. Abstracting of these papers on 5 X 8 punch cards also was begun.

Preparations for the determination of specific surfaces of porous media and their correlation, if any, with fluid flow were made. Construction of apparatus to determine specific surface of powders and porous substances was begun but is not yet completed.

15. INTERRELATIONSHIPS OF SOIL MOISTURE AND TEMPERATURE ON PLANT GROWTH AND PHYSIOLOGICAL FRACTIONS.

Project Number: 489 (W-67). Funds: Regional Research and State. Personnel: R. H. Maier.

This project was activated in July, 1959. An intensive review of the literature was conducted from the standpoint of soil moisture-temperature interactions and the effects of these interactions on plant growth. Also, a close scrutiny of the physiological and biochemical literature was conducted with reference to methodology for isolating discrete mineral-tissue fractions in plant tissue. Portions of necessary equipment have been assembled for the start of this investigation.

16. THE UPTAKE OF RADIOSTRONTIUM BY VARIOUS TYPE CROPS (IN COOPERATION WITH THE UNITED STATES ATOMIC ENERGY COMMISSION).

Funds: U. S. Atomic Energy Commission. Personnel: W. H. Fuller.

The Stanford Absorption technique was studied for adoption to uptake of calcium from soils by different plants. This procedure involves growing of plants in small containers in high density, the development of a dense root-mat and placing the root-mat against a soil. Chemical analysis of the plants after different periods of contact with the soil was used to evaluate the availability of the plant nutrient in question. The method gives satisfactory results for calcium. Soil calcium carbonate such as caliche was found to be only very slowly available to plants. Usually more calcium was absorbed from caliche the finer the particle size. The difference in uptake of calcium from caliche or soil lime by plants was not proportional to the difference in particle sizes used. Radiocalcium added to soils in a soluble form became less available to plants the longer it was in contact with the soils. Certain ionic exchanges are postulated.

17. EXISTENCE OF MICRONUTRIENT FRACTIONS IN PLANTS (IN COOPERATION WITH THE NATIONAL SCIENCE FOUNDATION).

Funds: Grant, National Science Foundation. Personnel: R. H. Maier.

This project was initiated in September, 1959, to study the location and change in content of particulate fractions of micronutrients in tomato plants. Studies on nutrient-solution growing techniques have shown that acid-washed quartz sand is not suitable for micronutrient investigations. Iron can be continually extracted from quartz sand over long periods of time. Small (1-3 mm.) glass beads are not suitable because the beads retain excessive amounts of moisture on their surfaces which restricts seed germination. Polythylene beads are most suitable since they offer no metal contamination and result in excellent percentages of seed germination.

18. THE EFFECTIVENESS OF POLYETHYLENE IN THE CONSERVATION OF SOIL MOISTURE AND IMPROVEMENT OF CROP PRODUCTION (IN COOPERATION WITH U. S. INDUSTRIAL CHEMICAL COMPANY).

Funds: U. S. Industrial Chemical Company. Personnel: D. M. Anderson.

The influence of polyethylene film coverings on the germination and seedling survival of cotton, sudan grass, lettuce, mustard, alfalfa, and sour clover was determined at approximately five-week intervals. The main effects of the film coverings were to modify soil temperatures, prevent evaporation of soil water, and reduce sunlight incident on the soil. Temperatures were higher in soil under the films than in uncovered soil. Germination was either improved or depressed due to this effect depending on the kind of seed and the time of year. Once

sprouted, seedlings never suffered from lack of water in the plots covered with the films whereas in uncovered plots this was not true and water had to be supplied. Plants grown under films of all opaque colored films suffered from a lack of sufficient sunlight and eventually perished, whereas those grown under the clear, transparent films apparently were thriving when the tests were stopped.

19. MAGNESIUM STATUS OF SOME ALKALINE, CALCAREOUS SOILS. (IN COOPERATION WITH INTERNATIONAL MINERALS AND CHEMICAL COMPANY).

Funds: International Minerals and Chemical Company. Personnel: R. H. Maier.

This project was initiated in July, 1959. A chemical survey of the magnesium status of some Arizona soils was conducted. The ammonium acetate-soluble magnesium as well as water-soluble, sodium nitrate-soluble, and percent magnesium saturation were determined for 16 soils. The percent magnesium saturation values ranged from 1.7 to 70.5% with values less than 10-15% indicative of possible plant growth response to additional magnesium. A rapid soil extraction method for magnesium using sodium nitrate was compared to the more lengthy universal ammonium acetate method. A highly significant correlation between the two methods was obtained.

20. NITROGEN SOURCE AND TIME OF APPLICATION ON COTTON. NITROGEN IN RELATION TO COMPOSITION, VEGETATIVE AND FRUITING HABIT OF COTTON (IN COOPERATION WITH U.S. STEEL CORPORATION).

Funds: U. S. Steel Corporation. Personnel: T. C. Tucker.

Ammonium nitrate, ammonium sulfate, calcium nitrate, anhydrous ammonia, and urea were compared on cotton at two soil moisture levels and applied as sidedress and preirrigation applications. Sidedress applications were more effective than preirrigation and greater N response resulted at the higher soil moisture level. Calcium nitrate was inferior to other sources studied. Nitrogen effects on cotton at different physiological stages were studied in two experiments. Nitrogen was applied at different stages of growth and vegetative, fruiting habits, and nitrate-N composition of petioles were related to nitrogen application and yield. Initial soil N status appeared to influence the effect of the N variables on the characteristics measured. Flowering and fruiting were related to yield and the N status of the plant.

21. THE USE OF PLANT TISSUE TESTING TECHNIQUE IN THE PREDICTION OF FERTILIZER NEED FOR COTTON AND OTHER CROPS (IN COOPERATION WITH PRIVATE GRANTS-IN-AID).

Funds: Private Grants-in-Aid. Personnel: Ellsworth Shaw.

Observation on commercial fields of nitrate levels found in barley plants, associated with crop history, fertilizer practice, planting date, rate of elongation, watering practice, soil texture approximations, plant physiological stage approximation, and visual color observations.

Adaptation of the project leader's standard form for carrying this information in a readily communicable and understandable manner.

Organization for periodic observations of above nature on about 50 fields throughout the growing season of 1959-60.

22. COMPARISON OF SEMI-QUANTITATIVE TISSUE TESTS WITH RESPECT TO NITRATE NITROGEN IN CERTAIN CROPS INCLUDING COTTON, BARLEY, AND SORGHUM.

Funds: Collier Carbon and Chemical. Personnel: T. C. Tucker.

Rapid tissue test and quantitative tissue analyses were compared on cotton and grain sorghum for nitrate-nitrogen. Nitrate nitrogen in cotton petioles indicated the nitrogen status of the plant accurately and reflected the uptake of nitrogen from applied fertilizers. In the low range of nitrate the rapid test values followed closely the laboratory determination indicating deficiencies can be diagnosed by either method.

23. POSITIONAL AVAILABILITY OF FERTILIZER NITROGEN AND PHOSPHORUS AS RELATED TO PHYSIOLOGICAL STAGE OF PLANT AND TIME OF APPLICATION.

Funds: California Spray-Chemical. Personnel: T. C. Tucker.

Radioactive mitricphosphate fertilizer was obtained from the U. S. Atomic Energy Commission and the USDA, Beltsville, Maryland Pilot Plant for applying to Arizona soils to fulfill the following objectives: To study the feasibility of the application of small quantities of fertilizers throughout the growing season of cotton, to provide a continuous supply of plant nutrients, and to study the effectiveness of phosphate fertilizers as related to the stage of growth of the cotton plant. It is also intended to study the interaction of nitrogen and phosphate in fertilizers when applied singly and in chemical combination. The radiotracer technique is being used as a tool to positively identify the uptake of various fertilizer sources of different water solubilities by the cotton plant throughout its growing period.

24. MECHANICS OF WATER TRANSPORT IN UNSATURATED SOILS.

Funds: U. S. Army Signal Corps. Personnel: D. M. Anderson.

The hypothesis is being tested that water flow in unsaturated soils is an active process. Analyses of experimental data indicate that there is a marked increase in temperature fluctuation in the soil with an increase in environmental temperature. Also, there seems to be an increase in both the vapor velocity and liquid velocity in soils with an increase in temperature. With the present instrumentation both liquid and vapor movements are observed simultaneously, making the motion of the separate velocities difficult. A device to permit the measurement of vapor velocity alone is being built.

An attempt is being made to identify and evaluate the components of activation energy.

25. WATER QUALITY AND BERMUDA GRASS PRODUCTION IN THE SOUTH GILA IRRIGATION DISTRICT.

Funds: Yuma Irrigation District. Personnel: W. H. Fuller, Harold Kreizinger, George Draper.

Field experimentation was undertaken to determine the effect of nitrogen and phosphorus both singly and together on the seed production of Bermuda grass in the South Gila Irrigation District.

26. QUANTITATIVE PROCEDURE FOR $\mu\,\mu$ AMOUNTS OF SILVER IN RAIN DEPOSITS.

Funds: Atmospheric Physics. Personnel: R. H. Maier.

A procedure is being developed to determine micro quantities of silver in rain water. The importance of this procedure is in the identification of silver that might be found in rainwater after cloud seeding with silver iodide.

Department of
AGRICULTURAL ECONOMICS

1. RESOURCE REQUIREMENTS, MANAGEMENT PRACTICES, AND MEASURES OF EFFICIENCY IN FEEDLOT OPERATIONS.

Project Number: 381. Funds: Hatch and State. Personnel: Leo J. Moran

Analyses of a 1958 survey of Arizona cattle feeders was completed and the results were published as Technical Bulletin 138 of the Arizona Agricultural Experiment Station entitled, "Nonfeed Costs of Arizona Cattle Feeding."

This project is being closed, June 30, 1960.

2. THE EFFECTS OF FIRES ON COTTON GINNING COSTS AND POSSIBLE MEANS OF REDUCING FIRE LOSSES IN ARIZONA.

Project Number: 392 (SM-17). Funds: Hatch and State. Personnel: Charles A. Wilmot.

During the six months' operation of this project in 1959 (January 1 to June 30), the collection of data relative to gin fires and insurance coverages was completed. This was accomplished through visits to gin managers of all cooperating gins, insurance agents, the Arizona Fire Rating Bureau and the Arizona State Insurance Commission. These data have all been sent to the Georgia Experiment Station for the purpose of processing onto IBM cards.

Data on gin fires and fire insurance coverages have now been obtained on a sample of 89 gins for the past three ginning seasons. Information relative to the origin, cause, and damages from nearly 2000 cotton fires in and around gins in Arizona was collected. Information on fire insurance coverages, costs, and collections for the sample gins was also obtained for this period.

The analysis of the 2,000 gin fires will point out the cause, frequency, and extent of gin fire damage and the costs resulting from these losses. It is expected that a further analysis of these fires according to various fire preventive devices and combinations of cleaning and drying equipment will furnish ginners a basis for equipping their gins with the most effective means of reducing fire hazards. It is hoped that the data from the study will result in equitable adjustments in insurance rates for the adoption of improved fire preventive devices and practices where the data indicate adjustments are justified.

This project was terminated as a Regional project as of June 30, 1959. Final tabulations, analyses, and preparations for the state report are now being conducted.

3. THE ECONOMICS OF MARKETING HAY AND FEED GRAINS IN ARIZONA.

Project Number: 415 (WM-20). Funds: Hatch and Regional Research. Personnel: R. C. Angus.

Federal hay grades were obtained on seventy-four hay samples collected in the Yuma and Salt River Valley areas. A short interview of farm operators who contributed the samples was obtained. These data will be analyzed to determine the relationship between hay quality and hay prices.

New personnel were familiarized with this research project and with the major agricultural areas in Arizona. Plans were made to cooperate with New Mexico to evaluate a weekly hay price newsletter.

It is expected that the factors which affect farm hay and grain prices will be isolated. These factors would be guides to producers in managing their enterprises.

An analysis of the hay quality and hay price data is planned. A weekly newsletter on hay prices will be sent to a group of producers during the season. At the end of the season, the prices obtained by growers who received the letter will be compared with prices received by a control group of growers.

4. ECONOMIC ANALYSIS AND EVALUATION OF THE USE OF FIBER TESTS IN THE MARKETING OF COTTON.

Project Number: 426 (SM-18). Funds: Regional Research and State. Personnel: Charles A. Wilmot.

Arizona assisted in the preparation of a Regional report on the use of cotton fiber tests by cotton mills based on a survey of Southeastern cotton mills made during the summer of 1958.

The types of fiber tests conducted by spinners, the test specifications which they have established, and the reasons for their increased use of such tests are of prime concern to Arizona merchants, shippers, ginners, producers and breeders alike since it is the responsibility of this group to make available lint of a quality which spinners are demanding if they, as individuals, and the Arizona Cotton Industry, as a group, are to survive and grow.

Although the Regional project was revised in 1957 to allow for the admission of Home Economists and a sixth objective "The effect of selected properties of raw cotton upon product quality and end-product performance," the original five objectives have now been satisfied. Consequently, at the June meeting, consideration was given to the development of a replacement project.

As a result the Arizona representative was appointed chairman of a three man committee to draw up a replacement project statement. The resulting project outline was submitted for approval to each member of the Technical Committee early in October. Following the acceptance of this outline by a majority, the chairman submitted it to the administrative advisor for the region.

A state contributing project outline has also been developed and submitted.

5. EFFECTIVENESS OF PROGRAMS DESIGNED TO INCREASE THE CONSUMPTION OF DAIRY PRODUCTS.

Project Number: Hatch 442 (WM-36) Funds: Hatch, Regional Research and State. Personnel: J. S. Hillman.

The material gathered on advertising and promotion practices of Arizona dairy handlers has been organized for publication, and will be issued as a mimeographed report from this Station. All of the analytical work has been completed on a regional publication, which should be issued shortly by Oregon State University. Copies of both of these works will be distributed to producer organizations and handlers of Arizona dairy products.

6. APPRAISAL OF OPPORTUNITIES FOR ADJUSTING FARMING TO PROSPECTIVE MARKETS.

Project Number: Hatch 452 (W-54). Funds: Hatch, Regional Research, and State. Personnel: Aaron G. Nelson.

Primary effort during 1959 has been directed to assembling basic data pertaining to crop production on farms raising cotton in the area being studied. A survey was made of a sample of farmers drawn from County Agricultural Stabilization Committee lists of those with cotton allotments in 1959. Since the ASC lists were based primarily on ownership, it was necessary to make a large number of combinations in arriving at an "operator" list from which to draw the sample. The sample was drawn on a random basis to permit obtaining information on five farm size groups ranging from 80 acres to three sections. The questionnaire was designed to give information which could not be obtained from other sources. This included the cropping system, production, rental arrangements, labor and wage rates, farm buildings, power and machinery, water and irrigation facilities, number of irrigations, fertilizer, seed, insecticides, custom operators, and selected farm expense items, together with the allocation of items to crops, livestock and non-farm uses. This information will be used along with that obtained from other sources to provide input-output data for analysis of crop production in the area being studied. For the time being, the project is being limited to a study of cropping systems.

Some attention was devoted to the "Cotton Wheel," reported last year. This department collaborated with Dr. George Campbell, Extension Economist, in bringing it up to date for use of farmers in 1960.

7. TRANSPORTATION OF LIVESTOCK AND MEATS IN ARIZONA.

Project Number: 459 (WM-37). Funds: Hatch, Regional Research and State. Personnel: R. E. Seltzer.

Summary of livestock movement by origin and destination has been completed. A comprehensive analysis of rates by truck and by rail from Arizona origins to Los Angeles (which receives about 75 per cent of Arizona's shipments) has been completed and the pattern of rates has been established. Preliminary analysis of the conditions underlying this rate structure has also been completed. Results to date indicate a very irregular pattern of truck rates for livestock shipped from Arizona origins, rates varying from below truck-operating costs where back hauls are important to high rates in the more remote areas of the state. Schedules for collecting additional rate and service information from ranchers, cattle feeders, and truckers have been prepared and tested.

The results of this study should be of specific value in adjusting the livestock transportation rate pattern in Arizona to a more equitable basis. These rates, together with rates on meat and feed, will be used to construct an economic model designed to answer questions relative to the location of livestock feeding and processing installations in the West.

Master of Science Thesis, Movement and Transportation of Arizona Cattle, James S. Hill, 119 pp., October, 1959.

8. EVALUATION OF THE EFFECT OF COMMERCIAL CATTLE FEEDING OPERATIONS ON METHODS OF SALE AND PRICES RECEIVED FOR SLAUGHTER CATTLE IN ARIZONA AND SOUTHERN CALIFORNIA.

Project Number: 460 (WM-39). Funds: Hatch, Regional Research, and State. Personnel: Thomas M. Stubblefield and Norman Gene Wright.

Price data on live weight and grade and yield sales were gathered on approximately 25,000 head of cattle sold out of Arizona and Southern California feedlots in 1959. These data will be analyzed during 1960. Price data for cattle sold out of Arizona and Southern California feedlots for 1958 were analyzed. The live weight prices received for fat cattle sold in the Phoenix, El Centro, Visalia, Stockton, Los Angeles, and Denver markets during 1957 and 1958 were analyzed to determine if the Central Markets, Denver and Los Angeles, had any price advantage over the "country" markets of Phoenix, El Centro, Visalia, and Stockton. The results do not show any advantage for the Central Markets with the exception for the class of heifer choice grade. The Denver market showed a price advantage for this class and grade of cattle.

It is thought that this project will help the individual feeders in determining the best method of selling their fat cattle during the various seasons and market conditions which exist in the Arizona-California marketing areas.

The above discussed work will continue. Manuscripts will be prepared and reports issued on methods of marketing used by feedlot owners who have less than 1,000 head capacity; the correlation between live weight and yield with grade of cattle, and the comparison of the prices received for slaughter cattle at the Phoenix, El Centro, Visalia, Stockton, Los Angeles, and Denver markets.

9. A STUDY OF THE ECONOMIC CONSEQUENCES OF CONTROLLING VELVET MESQUITE IN DESERT GRASSLANDS OF ARIZONA.

Project Number: 474 (W-16). Funds: State Research. Personnel: Thomas M. Stubblefield.

Arizona's project was activated July 1, 1959. Arrangements have been made to gather physical input data on the bulldozing and chaining velvet mesquite. The U. S. Forest Service has been contacted to obtain data on forage response from experimental data from the Santa Rita Experiment Station. Methods for estimating costs of ranching operations and returns in Southern Arizona have been studied and procedures for obtaining this data have been established.

The study is not far enough along to determine the usefulness of findings. It is expected that this study will prove valuable to ranchers in Southern Arizona and Southwestern New Mexico who are considering removing velvet mesquite from their ranches by chemical and mechanical means.

Field work in gathering input data on the removal of mesquite by mechanical and chemical means will be continued in 1960. Case studies of budgets for selected ranchers will be made to determine costs of operating ranches in Southern Arizona.

10. INFLUENCE OF RECENT TECHNOLCGICAL DEVELOPMENTS ON THE MARKETING AND MARKET ACCEPTANCE OF WESTERN CCTTON.

Project Number: 490 (WM-41). Funds: Regional Research and State. Personnel: Charles A. Wilmot.

During the six months' operation of the project in 1959, considerable secondary data have been assembled and some preliminary contacts, of an informal nature, have been made with various segments of the marketing system for purposes of determining numbers, locations, and distribution of cotton marketing firms. Sampling procedures have been developed and some work on the preparation of schedules for collecting data have been completed.

Plans have been formulated to survey a sample of gins, compress-warehouses, merchants, and other elements of the cotton marketing system to determine the degree and rate of acceptance of recent technologies and the various factors influencing decisions relative to the adoption of these technologies.

These findings will then be assembled and analyzed to ascertain the effect which each has had on (1) the marketing system, in general, and (2) the utilization and market acceptance of western cotton.

11. THE COST OF OWNING AND OPERATING FARM POWER AND MACHINERY USED IN PREPARING LAND FOR PLANTING OF ARIZONA FIELD CROPS.

Project Number: Hatch 494 (W-62). Funds: Hatch, Regional Research and State. Personnel: Leo J. Moran (Agricultural Economics), K. K. Barnes (Agricultural Engineering).

This project was activated July 1, 1959, for the purpose of determining the cost of owning and operating preplant tillage machines on Arizona farms. Thus far a schedule to be used in collecting this cost data has been prepared, and pretesting of this schedule has been undertaken.

12. DETERMINING AND SHARING COSTS AND BENEFITS FROM DEVELOPMENT OF THE CENTRAL ARIZONA WATERSHED.

Project Number: 495. Funds: State. Personnel: M. M. Kelso.

Work completed during and in progress at the end of 1959 was concerned with the economic consequences of alternative combinations of water and land in cotton production in Central Arizona, the economic consequences of a falling water table on agricultural income in that area, and the over-all procedures most useable in analyzing, economically, the alternative schemes that might be used in supplying more water for agriculture in Central Arizona. This latter effort in its full comprehensiveness will involve evaluation of benefits and costs from watershed modification in Central Arizona, as well as the costs of importing water from outside the basin and the comparative values of using such additional or existing water supplies for agricultural and nonagricultural purposes in the area.

13. RETAILING MEATS AND MEAT PRODUCTS IN ARIZONA.

Project Number: 496. Funds: Title II and State Research. Personnel: R. E. Seltzer and T. M. Stubblefield.

This project is aimed at describing and analyzing meat retailing and meat display and advertising practices of Arizona retail food stores. The policies and practices of these stores relative to meat sales will be related to volume of sales and to variations in wholesale and retail meat prices. The effect of variations in display, pricing, and advertising relative of volume of sales will be determined.

14. PRODUCTION, PRICES, AND COSTS FOR ARIZONA FARM AND RANCH PRODUCTS.

Project Number: 497. Funds: State. Personnel: Raymond E. Seltzer.

This is a continuing project which has as its purpose the development of trends in acreage, yield, production, and value of Arizona's principal crops, together with projected costs for the production of these crops. Livestock numbers, production, and value are also analyzed. An annual study is made of the supply-price-cost relationships for factors of production and crops and livestock produced. These relationships are reported in an annual bulletin, Arizona Agriculture 1960, the 30th in this series.

This work is widely used throughout the state. It provides a record of the progress of Arizona's agriculture and the crop budgets are used extensively by financing agencies. Ten thousand copies are printed.

This project will continue along the same lines as in the past.

15. AN ECONOMIC EVALUATION OF THE IMPACT OF UNITED STATES AGRICULTURAL EXPORT PROGRAMS ON DOMESTIC AGRICULTURE AND AGRICULTURAL RELATED INDUSTRIES.

Project Number: 499 (IRM-1). Funds: Regional Research and State. Personnel: J. S. Hillman.

Work was initiated during the fall of 1959 on this study of United States agricultural export and surplus disposal programs, and especially the PL 480 program in light of its stated policy objectives set forth in Section 2 of the original Agricultural Trade Development and Assistance Act of 1954, as amended. This project will have as its major aims: (1) to briefly analyze the history of United States proposals and programs to subsidize its agricultural products in the world market; (2) to evaluate the impact of the PL 480 program and related export programs on United States agriculture; and (3) to appraise the impact of such governmentally-stimulated exports on the nonagricultural economic welfare and to determine the net economic benefits of such programs on the total economy of the United States through an evaluation and measurement of the intersector economic transfers within the economy.

16. RESOURCE REQUIREMENTS AND SUPPLY RESPONSE ON ARIZONA DAIRY FARMS IN RELATION TO THE FUTURE DEMAND FOR MILK IN ARIZONA.

Project Number: 2RC (USDA) Milk Market. Funds: Research Contract. Personnel: James S. Hill, L. J. Moran, R. E. Seltzer.

This project was initiated January 16, 1960. A preliminary study of similar work in resource requirements and supply response is in progress. Personal visits to a number of dairy farms and processors have been made to determine some of the problems found by the Arizona dairy industry at the present time. Data have been collected on cow numbers, milk production, milk prices, population and various other material deemed necessary for the study. A survey of the dairy industry to determine resource requirements in the production of milk is in the planning stage.

The results of this study should be useful to administrative personnel charged with the operation of the Central Arizona Federal Market Milk Order No. 104, and individual producers and processors in planning for growth and stability in the dairy industry.

Detailed case study analyses will be made of input-output relationships within different size categories of dairy farms in sufficient numbers to gain adequate knowledge of resources required and costs involved for typical dairies within each size category. Economic model dairy farms will be constructed.

17. MARKET APPEAL OF MILK BEVERAGES AS AFFECTED BY FAT AND SOLIDS-NOT-FAT.

Project Number: 2 E & G. Funds: American Dairy Association. Personnel: J. S. Hillman and J. W. Stull.

During the past year, work was completed on the consumer preference study which involved sampling of over 14,000 persons in schools, markets, and various public gatherings. Preferences were determined for milk beverages with fats and solids-not-fat (SNF) standardized at various levels. The results of these tests have been published in technical and popular form and will provide a basis for further research during the coming year. The principal objective of this research is to collect data which will provide a basis for standards and practices relating to optimum milk beverage composition.

Department of
AGRICULTURAL ENGINEERING

1. MECHANIZATION OF COTTON PRODUCTION AND HARVESTING.

Project Number: 269 (W-24). Funds: State, Hatch, and Regional Research. Personnel: M. D. Cannon, W. L. Kern, K. K. Barnes, and K. C. Hamilton, (Dept. of Agronomy).

Tests during 1959 included planting, weed control, and harvesting.

When using a conventional planter, seeds graded by size showed no increase in emergence over ungraded seed.

The application of Vapam prior to planting, even at very high rates, resulted in no significant weed control. Pre-planting applications of Diuron resulted in better weed control, better lint percentage and higher yields than did untreated checks. A layby application of Monuron was superior to flaming in controlling late-season weeds.

The Mitchell Stripper-Harvester harvested a higher percentage of the available cotton in the field than did two conventional spindle-type machines, although the trash and moisture content was higher when using the Mitchell machine.

Results of harvesting-spacing tests with Pima S-1 showed no correlation of population with harvesting efficiency, but high correlation between harvesting efficiency and total yield.

2. SPRINKLER IRRIGATION STUDIES UNDER ARID SOUTHWESTERN CONDITIONS.

Project Number: 303. Funds: Hatch and State Research. Personnel: K. R. Frost, H. C. Schwalen, L. Burkhart, and D. R. Rodney.

Forage sorghum was grown under sprinkler irrigation replacing alfalfa which had been grown the previous three years. The treatments were the same as used on the alfalfa - frequent, regular daytime and night sprinkler irrigation and furrow surface irrigation. Sprinkler irrigation under the frequent treatments were made daily during hottest hours. Other treatment applications were made weekly as the crop required water.

Comparative Yields and Water Applications

Treatment	Yield Tons/A	Acre-Ft. Applied Per Acre	Yield in Tons per Acre-Ft.	Average Applied in Inches Per Day
Frequent Sprinkled	22.05	1.91	11.5	.25
Regular Sprinkled	20.40	2.21	9.3	.28
Night Sprinkled	25.98	2.31	11.2	.30
Furrow	24.44	2.32	10.5	.30

As indicated by the table, the heaviest applications were made with night sprinkling and furrow irrigated and resulted in highest yields per acre. Less water was used on the frequent daily sprinkled plots and resulted in more green forage per acre-foot of water. The furrow irrigated plots compared favorably with those under sprinkler since high flow per furrow was used with good control and percolation losses were negligible.

The permanent sprinkler irrigation system installed in young lemon trees on the Yuma Mesa was in operation for the second year. About one-half the water (2-inches) was applied on the sprinkled rows as with the flooded (4-inches). Irrigations were made every twoweeks during the summer. Sprinkled trees continue to appear greener and have more growth than the flooded trees as was the case the first year.

3. SURFACED RUNOFF BASINS AS A SOURCE OF WATER ON SEMIDESERT AREAS.

Project Number: 330. Funds: State. Personnel: R. J. Shaw and E. M. Schmutz (Watershed Management).

No additional rain collectors were installed in 1959. The one at Mr. DeGrazia's home was maintained in operation. The plastic covering the collector area is in fair condition, though some holes have developed in brittle spots. These have been patched without trouble and after 21 months' service is still in satisfactory condition. The water is filtered through a "Cuno" filter and it has been necessary to change the element once. The water is sterilized by the addition of 0.5 cc of "chlorox" or equivalent per gallon of water. This is added while pumping from a low level storage tank to a higher gravity tank to supply pressure for domestic use. The water passes the tests of the Public Health Service.

The storage tank below the asphalt paved collector area at Page Ranch, which had been left dry by the failure of the winter rains of 1957-58, refilled and ran over during the summer of 1958. One-half the sheet aluminum roof on the storage tank blew off, and was replaced. There is no explanation of how this happened unless it was in the path of a large "twister." The pavement area is being invaded by shrubs. This is not serious as yet, but will have to be controlled. The pavement is showing signs of stress, in the form of cracks, which will require attention within the next two years.

4. HYDROLOGY AND WATER UTILIZATION OF SMALL, SEMIDESERT DRAINAGE AREAS.

Project Number: 375. (W-32). Funds: Hatch, State, and Regional Research. Personnel: D. W. Fonken and H. C. Schwalen.

OPERATIONS:

Precipitation and runoff measurements were continued for the 18-square-mile Atterbury Watershed ten miles southeast of Tucson. Twenty-seven standard 8-inch raingages and four weighing type recording gages provided rainfall measurements on a one-mile grid over the entire basin. In addition, 28 plastic gages were maintained during the summer thunderstorm period which provided gages on a 1/3-mile grid for a four-square-mile area. Runoff was measured at each of the three reservoirs and the flume.

Facilities for recharge investigations were constructed during the year. These included a floating outlet control system, a flocculation pit and a recharge pit. Due to transfer of the reservoir site to a subdivider, the Lusk Corporation, use of these facilities will probably be limited to one small test which was completed March 25, 1960. The former owner and cooperator, Mr. B. Atterbury, is to be commended for his fine attitude toward our research work on his property.

Urbanization of the lower end of the watershed is expected within the next few years. This will probably eliminate the recharge aspects of this project, but at the same time introduce an opportunity to evaluate the effects which urbanization will have upon the hydrology of the basin - especially in regard to increased runoff as a future water supply. Atterbury Dam (also known as Kinnison Dam) is to be removed, which will eliminate our present method of measuring runoff from sub-area II (8.1 square miles, the largest sub-basin). Every effort will be made to continue measurement of the runoff past Atterbury Dam site.

RAINFALL ANALYSIS:

For the calendar year 1959, annual point precipitation varied from 9.33 inches to 13.10 inches. Mean annual precipitation for the entire basin was 11.36 inches which is 106% of the 67 year mean at The University of Arizona Station. Analysis of data from the 1/3-mile grid is not yet complete, but it is expected that these data will better define the depth-area-relationships of our summer thunderstorm rainfall.

RUNOFF ANALYSIS:

Total runoff for the year was 404 acre-feet or 22.9 acre-feet per square mile. This amounts to 3.8% of the mean annual precipitation. There were 50 storm periods in 1959. However, 55% of the runoff was produced by only 3 of these storms.

CUMULATIVE RUNOFF COLLECTED IN RESERVOIRS - 1959

Number of Runoff Periods	Volume of Runoff Ac.Ft.	Percent of Total Annual Runoff	Equivalent Depth in Inches	Total Average Depth of Storms which Produced the R.O. Inches	Runoff as Percent of Storm Depths.
1	114.7	28	0.122	.66	18.5
2	177.2	44	0.189	1.27	14.9
3	223.7	55	0.238	1.77	13.5
4	264.6	65	0.282	2.35	12.0
5	294.2	73	0.313	2.61	12.0
6	319.3	79	0.340	2.99	11.4
7	338.4	84	0.361	4.02	9.0
50	404.2	100	0.431	11.36	3.8

Disposition of the 1959 runoff is shown in the following table. Evaporation losses were calculated by use of corrected land pan evaporation rates.

	Atterbury Reservoir	Tank No.2	Tank No.3	Total
Total Runoff (Ac. Ft.)	301.9	98.6	3.7	404.2
Evaporation loss	33.8	13.3	0.8	47.9
Spillway loss	0.0	4.9	0.0	4.9
Storage, Dec. 31, 1959	35.6	1.2	0.1	36.9
Infiltration	232.5	79.2	2.8	314.5

During 1959 about 12% of the runoff evaporated from the free water surface, 1% over the spillway at Tank 2, 9% remained in storage, and 78% seeped underground. The disposition of that part which seeped underground is not known.

5. THE PRODUCTION AND UTILIZATION OF TAMARISK (TAMARIX ARTICULATA).

Project Number: 400. Funds: State. Personnel: K. R. Frost and H. C. Schwalen.

Annual inspection of the 141 treated fence posts set on the Kinne Ranch near Coolidge in 1935 showed 74 had failed to this date. Thirty-eight of the posts that failed had been treated green with coal-tar creosote and 36 treated dry.

No failures occurred this year in the 50 posts treated green and dry with wood-tar creosote, coal-tar creosote, zinc chloride and pentachlorophenol which were set on the Page Ranch in 1942 under dry desert conditions. Total failures to date are: wood-tar creosote treated, 5 green and 5 dry; coal-tar creosote treated, 2 green and 1 dry; pentachlorophenol treated, 1 green and 1 dry. Only one of the 6 untreated posts set at the same time remains standing. None of the 51 posts similarly treated and set at the same time in the irrigated soil on the Campbell Avenue Farm remain standing.

6. GROUND WATER SUPPLIES.

Project Number: 436. Funds: State and Other. Personnel: H. C. Schwalen and R. J. Shaw.

Upper Santa Cruz Valley

The water level measurements made in the Spring of 1959 indicate substantial recovery as the result of flood flows from summer rains in 1958. The water level in the Nogales City pumping plant, located in an area of limited ground water storage, raised 30 feet as compared with a year previous. Recovery of the same amount occurred in the vicinity of old Calabasis and decreased northward to about two miles north of the Pima County line where no change had taken place.

Sahuarita - Continental District.

Pumping draft for irrigation in this district was principally responsible for a marked lowering in the water table. The greatest drop of 15 feet in water level occurred in a small area near Sahuarita. The lowering extended transversely across the valley from the buried rock pediment in the west to approximately six miles east of the Santa Cruz River or a total distance of over eight miles. Little change in water levels took place in the Indian Reservation above the San Xavier Mission where pumping draft had been reduced.

Tucson Area.

The continued expansion of the Tucson metropolitan area with development of water supplies in outlying areas has extended the area showing residual loss in groundwater storage. Under a large part of the metropolitan area water levels dropped between three and five feet between the Spring of 1958 and 1959.

Along Rillito Creek there was negligible recharge during the winter of 1958-59 and water levels in the Spring of 1959 were low. While in a few wells a loss of as much as 15 feet was recorded, this area is subject to rapid recovery from stream flow in Rillito Creek and such fluctuations in water level are not serious.

Cortaro Area.

There was reduced pumping draft in the center of the valley for irrigation in 1958. This combined with recharge from deep percolation losses in the use of sewage water for irrigation resulted in recovery of as much as five feet in water levels in the trough of the valley. Lowering continued under the Mesa lands in the Canada del Oro area amounting to between one and two feet.

Avra-Altar and Marana Area.

The 1959 Spring water level measurements indicate an average drop of the water table of about 5 feet compared with the previous year. Wide variations in the effect of pumping now occurs between local areas. In a few wells, losses of as much as 20 feet have been recorded and in others a rise of several feet. Variation in the annual pumpage from individual wells has a marked effect on the water levels in these wells, and no general pattern of lowering is discernible from the record of a single well.

The Three Points District continues to show no material effect from pumping and is an exception to all other parts of the valley.

Chino Valley

Early season pumping in the Spring of 1959, prior to water level measurements, resulted in apparently greater lowering than usual in artesian pressures and water levels. Water levels in those wells unaffected by pumping indicates that the loss was less than two feet or about the same as in previous years.

Observations in a few wells several miles east in Lonesome Valley indicates a yearly lowering of about the same amount. Pumping draft in 1958 was not materially different from that of the previous last few years.

7. IRRIGATION AND ROW SPACINGS OF SORGHUM.

Funds: State (Agr. Engr.), Hatch (Plant Breeding). Personnel: M. D. Cannon, F. Wiersma; and L. S. Stith, (Plant Breeding).

R S 610 sorghum was planted at the Marana Farm using two different row spacings, 40-inch and 20-inch with two seed spacings in the 20-inch rows. The difficulties in mechanization of planting was reduced by using a lettuce bedding machine and a good stand was established in all plots. All treatments were harvested twice.

No differences were found between irrigation schedules this season because heavy rains reduced the differences in actual available moisture between treatments to practically zero.

Yields in the 40-inch spacings averaged about 4-3/4 thousand pounds per acre compared to 5-3/4 thousand pounds in the 20-inch rows from the first cutting. There was no difference in yields between the two plant spacings within the 20-inch rows.

An additional yield of about 2-1/2 thousand pounds per acre was harvested from all treatments in a second cutting with no differences in yield between treatments.

Department of
AGRONOMY

1. THE CONTROL OF WEEDS ON IRRIGATED LANDS.

Project Number: 261. Funds: Hatch and State. Personnel: K. C. Hamilton, (H. F. Arle and G. N. McRae, ARS Collaborators), G. D. Massey, R. A. Nelson, R. K. Thompson.

Cotton - Directed and general applications of monuron and diuron sometimes caused stunting and temporary chlorosis but did not reduce yields or fiber quality. Combinations of urea herbicides with contact or systemic herbicides increased control of weeds established before the layby applications. Preplant applications of diuron controlled annual weeds for the entire season. Dalapon applied directly at low rates or as a spot treatment at high rates in young cotton did not affect yields; directed soil applications at layby delayed maturity and reduced boll size.

Sorghum - Foliage applications of 2,4-D caused abnormal plant development but did not reduce grain yields. Soil applications of diuron reduced yields.

Alfalfa - Foliage applications of dalapon, 4-(2,4-DB) and DNBP in seedling stands and soil applications of diuron in established stands reduced hay yields in the first cutting after treatment.

Corn - Foliage applications of 2,4-D caused abnormal root development but did not affect yields. Preplant applications of triazine herbicides were more effective than later treatments.

Soil Residues - The only residues affecting subsequent crops resulted from applications of higher rates of urea and triazine herbicides.

Perennial Weeds - 2,3,6-TBA destroyed established field bindweed. EPTC retarded sprouting of nutgrass for six to ten weeks.

2. COTTON PRODUCTION UNDER IRRIGATION.

Project Number: 264. Funds: Hatch and State. Personnel: R. E. Briggs, L. L. Patterson, R. A. Nelson, Edna Lewis, Jeane Millane. (In cooperation with the Departments of Agricultural Chemistry and Soils and Plant Breeding.)

There was a linear relation of plant spacing and yield in a test at Yuma. As plant spacing increased, yield decreased comparing spacings of 5, 10, and 18 inches.

In a study of five Acala 44-WR strains, seeds of the strains which absorbed more water in the laboratory emerged faster both under greenhouse and field conditions.

Three long staple varieties germinated more rapidly than the short staple varieties A-44 and A-44-WR when germinated with various sodium chloride concentrations.

On soil heavily infested with Verticillium Wilt, cotton yield in 1959 was significantly greater and wilt symptoms were less after a year of fallow compared to an area where cotton was grown following cotton. Fiber quality was not influenced.

Where Acromania or Crazy Top was severe, A-44-WR significantly out-yielded five other Acala varieties. Acala 44 was the poorest yielding variety and also had the earliest visual symptoms to the disorder.

For the second straight year, foliar applications of Gibberellic acid have not significantly increased yield; however, the various treatment yields have always been greater than the check. Except for boll size, none of the other main fiber properties were affected by Gibberellic acid.

In the Western Regional Variety Test at four locations, Acala 44-10-17 out-yielded A-44 at three of the locations. A Texas variety yielded well at all locations but the fiber quality would not be desirable for our marketing area.

Several rainbelt varieties yielded well in tests at two locations compared to A-44.

Yield of A-44 was not influenced by time of thinning when delayed until the plants were 24 inches tall.

Foliar application of the 2-3-dichloro analogue of Duraset did not influence plant type.

3. SEED PRODUCTION OF FORAGE PLANTS.

Project Number: 304. Funds: Hatch and State. Personnel: N. Wright, E. B. Jackson, A. A. Baltensperger, L. P. Hamilton. (In cooperation with Watershed Management, and Forest and Range Research Branch, ARS).

Seed yield comparisons among five varieties of side-oats gramagrass, three lovegrass species, three switchgrass strains and blue panicgrass at the Mesa Branch Station were concluded in 1959. Tucson side-oats gramagrass continued to be the best fall seed producer. Highest pure-live seed yields were obtained from the fall harvest. Uvalde was again the highest for summer harvest followed by El Reno and Vaughn.

The data suggested that germination of caryopses vs. florets varies between varieties of side-oats gramagrass. Blue panicgrass seed yield showed a linear response to nitrogen fertilizer. The highest yield was 850 pounds per acre with 180 pounds N while the check yielded 100 pounds per acre. The lovegrasses did not respond to higher rates of nitrogen, 120 and 180 pounds per acre. Seed yields of Wilman lovegrass, Boer lovegrass and Weeping lovegrass were 150, 450 and 850 pounds per acre. Switchgrass produced no seed.

Final results of a two-year study of the effect of dates, pre-treatments, and fertilizers on seed-set and seed production of black gramagrass were obtained in 1959. Potassium significantly decreased seed-set in 1957, but was not significant in 1958. Seed-set showed a highly significant increase when growth was initiated on August 15 rather than on August 1, in 1958, while in 1957, dates were nonsignificant. Pre-treatments, N, P, and all interactions were nonsignificant for seed-set. A highly significant seed yield increase was found for dates when growth was initiated on August 1 as compared to August 15. Pre-treatments, fertilizers, and all treatment interactions were nonsignificant for seed yield. Seed quality studies are to be completed.

Breeder seed of the four inbred lines of Gahi-1 pearl millet was produced for the National Foundation Seed Project. The lines were grown under isolation at the Branch Experiment Stations.

A technique has been developed for determining black gramagrass seed-set. The procedure was to place inflorescences in an .8 percent sodium hypochlorite-water solution. Glumes, lemma and palea were sufficiently bleached for the caryopsis to be seen while florets void of caryopsis were easily observed.

Experimental plantings of blue panicgrass and bermudagrass were established in the fall of 1959 on the Yuma Valley Branch Experiment Station. These tests are to study seed-set, seed quality and seed yield. Treatments will include harvest dates, fertilizers and irrigation.

4. THE IMPROVEMENT AND CULTURE OF SMALL GRAINS.

Project Number: 305. Funds: Hatch and State. Personnel: A. D. Day, R. T. Ramage, R. K. Thompson, G. D. Massey, L. C. Chapman, T. C. Tucker, and A. R. Kemmerer. (In cooperation with Cereal Crops Branch, Crops Research Division, ARS. Departments of Agricultural Chemistry & Soils and Agricultural Biochemistry.)

Variety yield tests of barley, oats, and wheat were grown at three locations in Arizona: Yuma, Mesa, and Safford, in an effort to select adapted varieties for these three areas.

Five experiments conducted over a four-year period (1955-58) at Mesa to study the use of oats for winter forage in Arizona were completed and summarized.

Eight experiments conducted over a two-year period (1957-58) at Cortaro to study the production of small grains pasture forage with sewage effluent were completed and summarized.

Breeding nurseries were grown at Tucson and Mesa and a number of crosses were made in an attempt to incorporate some of the desirable characteristics of unadapted varieties into the recommended Arizona varieties.

An experiment was initiated at Tucson to compare visual selection versus randum selection as methods of making high-yielding F_6 selections from barley populations.

A salt tolerance experiment was initiated at Safford to study the possibility of using the recurrent selection method of breeding to intensify the expression of salt tolerance in barley.

Male sterility is being backcrossed into four barley varieties adapted to Arizona: (1) Arivat, (2) California Mariout, (3) Harlan, and (4) Vaughn.

Seeds of two barley varieties (Arivat and Harlan) were irradiated with "X-rays" and "thermal neutrons" to study the possibility of artificially inducing desirable mutations.

An experiment was continued at Mesa to study the effect of paradichlorobenzene crystals, naphthalene crystals, and DDT powder on the germination of field crop seeds in storage.

A number of barley, oats, and wheat composites and bulks were grown at Yuma and Mesa.

Small grains winter forage experiments were continued at Mesa.

5. ALFALFA IMPROVEMENT.

Project Number: 341. Funds: State. Personnel: M. H. Schonhorst, R. K. Thompson, R. A. Nelson, A. R. Kemmerer.

A 3-year test was completed comparing Moapa alfalfa with commercial varieties. Average yields over this period were strongly and positively correlated with persistence of stand and reaction to the spotted aphid. Lahontan persisted best, Moapa intermediate and African poorest in this study.

Two-year production data using five varieties in border-size plots corroborated observations made on the small-plot test.

Border size plots of Moapa were grown. One-half were summer irrigated and the other half were not summer irrigated. Stand counts at three months and one-year indicated that the number of plants was reduced under both irrigation systems. Stand losses were somewhat greater under summer irrigation; however, summer dormant plots produced one ton less forage.

Two salt-tolerance studies on alfalfa have been established on the Safford Experimental Farm. One study consists of polycross progeny of approximately 100 spotted aphid resistant lines to determine whether or not variation exists in ability to persist and produce forage under high levels of salt. The second study consists of a border size plot planted to Moapa alfalfa which will be irrigated by well water only. Seed will be harvested annually and replanted to the same area each year. Remnant seed to be saved each year for planting at some future date to compare year-to-year changes in salt tolerance.

6. THE EFFECT OF LENGTH OF DAY AND CULTURAL METHODS ON THE REPRODUCTIVE POTENTIAL OF ALFALFA.

Project Number: 367 (W-58). Funds: Regional Research and State. Personnel: M. A. Massengale, D. F. McAlister, F. E. Todd, C. O. Stanberry. (In cooperation with Arizona Beekeeping; Insect Pathology Laboratory, ARS; Western Soil and Water Management Branch, ARS.)

Evaluation of the response of African and Vernal alfalfa to two different light regimes under field conditions was continued and enlarged in 1959. Alfalfa plants were exposed to the light treatments during two growth periods (May through July and August through October).

Response of plants to the light treatments was measured in terms of number of days from clipping to the appearance of the first flower, height of plants, dry weight and seed weight per plant. Of all the characteristics evaluated, the number of days from cutting to flowering proved to be the most sensitive to photoperiod.

The data showed that one-year-old alfalfa plants were more sensitive to photoperiod than three-year-old plants. During the August through October growth period, alfalfa seeded in the spring of 1959 required an average of 7.8 days longer to flower under natural daylength than those growing under light interruption. This difference was only 3.4 days for plants established in 1957.

Vernal was slower in flowering than African. Three-year-old plants of Vernal required an average of 5.1 days longer to flower than African plants of the same age. This difference was extended to 8.6 days in first-year plants.

In flowering response, Vernal reacted differently to the light treatments than African. The greatest number of plants opened one or more flowers from 15 to 19 days after cutting except Vernal growing under natural daylength. In this instance, the highest percent of plants began to flower 30 to 35 days after cutting.

Although differences were not significant, both varieties produced more vegetative growth (greater dry weight) under natural daylengths than long-day photoperiods

The influence of daylength on seed production was greater during the second growth period than the first. These data indicated that total seed production is not as sensitive to photoperiod as the initiation of flowering.

Some information was obtained which indicated that the less dormant plants within Vernal are the highest seed producers, and those plants which show the greatest winter dormancy are the low seed producers.

7. INFLUENCE OF CLIMATIC FACTORS ON FIBER PROPERTIES IN COTTON.

Project Number: 380. Funds: Hatch and State. Personnel: R. E. Briggs, Edna Lewis and Jeane Millane.

Approximately 1360 Acala 44 seed cotton samples from 19 gin locations were analyzed in the fiber laboratory in 1959. At each gin one sample was collected every day from September 15 to January 15 when possible. These samples were collected to determine the differences in fiber properties of the same variety of cotton throughout the harvest season grown at elevations ranging from 100 to 2600 feet. The following fiber properties were determined: lint percent, lint index, seed index, upper half mean length, mean length, strength, fineness, and maturity. The averages of each fiber property for a ten-day period have been calculated for each of the three years' data available. This information is now being used to determine correlations of the data between the three years using various areas based on elevation.

Fiber properties of the seed cotton samples collected from the 1959 crop are now being determined in the laboratory.

8. THE IMPROVEMENT AND CULTURE OF CORN.

Project Number: 394. Funds: State. Personnel: A. D. Day, R. K. Thompson, G. D. Massey, and L. C. Chapman.

Corn variety yield tests were grown at Yuma, Mesa, and Safford, Arizona in an effort to find corn varieties adapted to these three areas for both silage and grain production.

At the Yuma Experiment Station the following corn varieties were the five highest yielding silage and grain varieties: Silage - 1. Mexican June, 2. Texas 34, 3. Dixie 18, 4. DeKalb 1023, and 5. Funk G-711; grain - 1. Texas 38, 2. Pioneer 9178, 3. Funk G-144, 4. Funk G-711, and 5. Pioneer 302.

The following corn varieties were the five highest yielding silage and grain varieties at the Mesa Experiment Station: Silage - 1. Mexican June, 2. Funk G-787W, 3. Texas 32, 4. Texas 34, and 5. Texas 28; grain - 1. Funk G-144, 2. Texas 32, 3. Texas 36, 4. Texas 17W, and 5. Texas 38.

At the Safford Experiment Station the following corn varieties were the five highest yielding silage and grain varieties: silage - 1. Pioneer 9178, 2. Texas 34, 3. Pioneer 302, 4. Asgrow 101W, and 5. Dixie 18; grain - 1. Texas 17W, 2. Texas 32, 3. Texas 34, 4. Pioneer 9178, and 5. Funk G-711.

Since 1956, samples of Mexican June corn have been collected in a number of different areas in Arizona. Samples of the Indian corns grown in different areas of the state also have been collected. In 1959, seeds from the different samples of Mexican June corn and Indian corn were grown at Tucson and a number of crosses were made between different plants within each population (or "strain") to produce seed that would be representative of each individual strain.

9. PRODUCTION AND IMPROVEMENT OF NEW CROPS FOR ARIZONA.

Project Number: 401. Funds: Hatch and State. Personnel: D. D. Rubis, R. K. Thompson, G. D. Massey, R. A. Nelson; D. S. Black, W. H. Isom, L. H. Zimmerman, W. Bailey, USDA Collaborators. (In cooperation with Oilseeds & Industrial Crops Research Branch, ARS, USDA.)

Castor bean variety tests have shown that dwarf-internode hybrids are comparable to normal-internode hybrids in yielding ability. Intercrosses among the best dwarf inbred lines have been accomplished and tests for yield and combining ability will be conducted in 1960. In the safflower breeding project the sixth backcross was completed in transferring the thin-hull character to several commercial varieties; however, one cycle of recurrent selection among thin-hull lines has proven more successful than the backcross method in establishing thin-hull lines which set seed normally. Results from F_3 progenies indicate that more than one gene is involved in the expression of the thin-hull characteristic--complementary gene action is one probable explanation. The genetic studies in safflower have established no linkage groups thus far. In the soybean breeding program several selections made in bulked hybrids were very superior to the commercial variety, Lee, in yield and shattering resistance. In peanut tests in Yuma varieties of Virginia peanuts yielded three and four times that of the varieties of Spanish peanuts, the type grown commercially. Row spacing tests showed that Spanish peanuts must be grown closer than 30 inches for maximum yields.

10. CULTURE AND WATER ECONOMY OF SOIL IMPROVING CROPS.

Project Number: 402. Funds: Hatch and State. Personnel: D. D. Rubis, R. K. Thompson, G. D. Massey, L. N Wright. (In cooperation with Crops Research Division, ARS, USDA.)

Two experiments on the production and survival of several species of grasses and alfalfa under very limited irrigation is in progress at the Branch Stations at Mesa and Yuma.

Some results are available from the Mesa experiment which is in its third year. With differential irrigation treatments of one, two, and three irrigations (approximately 5 acre-inches per irrigation) per year, there has been little difference in survival among species but a considerable difference in spread and forage production. In 1959, Moapa alfalfa maintained stands and produced the most green-weight forage under all three treatments; whereas Side oats gramma and Turkestan Bluestem produced the least under all three treatments. The rank in order according to the amount of forage production varied among the other five grass species, namely, Wilman lovegrass, Boer lovegrass, Blue panicgrass, Panicum coloratum, and Pima pappus; and this order was practically reversed between one irrigation and three irrigations. There is an indication that some species may benefit to a different degree from irrigation at different times of the year even though their growing seasons are about the same.

11. THE EFFECT OF TEMPERATURE AND DAYLENGTH ON THE GROWTH AND DORMANCY IN ALFALFA.

Project Number: 468. Funds: Hatch and State. Personnel: M. A. Massengale, H. A. Brubaker and D. F. McAlister.

Twelve varieties of alfalfa were seeded in rows two feet apart in March, 1959. After seedling establishment, plants were thinned to 12 inches in the row. These plants were grown under two photoperiods, one being natural daylength (short days) and the other natural daylength plus an interrupted dark period of 20 minutes in the middle of the night (long days).

Data on plant height and percent of plants in flower were recorded at weekly intervals. When 90 percent of the plants of a particular variety within a light treatment had flowered, it was harvested. The green weight, dry weight, and moisture percent were recorded at each harvest.

Most of the data remains to be analyzed statistically; however, some responses may be noted. All varieties initially flowered more quickly and the first cutting was made earlier under long days than short days. Flowering of 90 percent of the plants of Medicago falcata was never attained under short days. The total number of harvests was more under long days than short for all varieties except Ranger, Buffalo and Chilean. These varieties were harvested the same number of times under both day-lengths. Even though the plants were cut a greater number of times under long photoperiods, the production of dry matter was higher under short days for all varieties except Rambler and Ladak.

During the winter months, the winterhardy varieties grew at a more rapid rate under long photoperiods. Caliverde and Hairy Peruvian made more growth under short days, however.

Diameter of the crown of all varieties except Medicago falcata was larger under short days with the greatest differences appearing in the more winterhardy varieties. Medicago falcata made no visible growth during the winter months under either photoperiod.

In an alfalfa management study, cutting throughout the growing season at the early to mid-bud stage of growth significantly reduced the total yield when compared to cutting at the one-tenth and full bloom stages. There was a significant difference in leaf to stem ratio between all stages of growth at the time of cutting. The highest percentage of leaves was found in the early to mid-bud stage of growth, and the lowest at full bloom. Protein analysis has not been made so far.

12. IMPROVEMENT OF ALFALFA BY BREEDING FOR INSECT AND DISEASE RESISTANCE.

Project Number: 473. Funds: Hatch and State. Personnel: M. H. Schonhorst, P. D. Keener, M. W. Nielson and V. D. Roth. (In cooperation with the Departments of Entomology and Plant Pathology; and the Entomology Research Division, ARS, USDA.)

A 3-year study was initiated in 1958 to compare visual selection with progeny performance of alfalfa lines in wide spaced single-row plots and closely spaced multiple-row plots. Information to date indicates that visual selection is not effective in determining combining ability in alfalfa for a complex character such as yield. Relative yields of polycross progeny, when grown in wide spaced single-row plots, were not consistent with their relative performance in closely spaced multiple-row plots. Part of this inconsistency is believed due to strain X row-spacing interaction and to a higher incidence of root and crown rot in the larger plots. Experimental synthetic combinations will be made using each of the methods. Performance of these experimentals will be used as the basis for determining an efficient method of clonal evaluation.

Cotton root rot studies on alfalfa selections were continued. Polycross seedlings of spotted aphid resistant clones of the varieties African and Lahontan will be grown in areas heavily and uniformly infested with the causal organism of cotton root rot, Phymatotricum omnivorum.

The 36 spotted aphid resistant Sirsa plants found last year have been vegetatively increased and will be established in an isolation block for seed production. Pea aphid tests are being conducted on these plants. Four of 13 plants tested were found highly resistant to both aphids. The remaining 23 plants will be tested in 1960.

13. THE GENETICS OF RESISTANCE TO THE SPOTTED ALFALFA APHID.

Project Number: 477 (W-40). Funds: State. Personnel: M. H. Schonhorst, G. D. Butler, W. F. McCaughey, M. W. Nielson, V. D. Roth. (In cooperation with the Departments of Entomology and Agricultural Biochemistry; and the Entomology Research Division, ARS, USDA.)

Tetraploid and diploid plants resistant, intermediate and highly susceptible to either one or both the spotted alfalfa aphid and pea aphid were self-pollinated and intercrossed in all possible combinations within the same chromosome level. Field tests were not successful due to inability to maintain spotted aphid populations in the field.

Biochemical tests were initiated to compare qualitatively and quantitatively the free amino acid level of lines and varieties of alfalfas with various levels of resistance to the two known biotypes of the spotted alfalfa aphid.

14. BERMUDAGRASS IMPROVEMENT.

Project Number: 502. Funds: State Research and 2RC Bermudagrass. Personnel: A. A. Baltensperger and Neal Wright.

1. Collection of germ plasm.

Bermudagrass plant material and seed lots were collected from various parts of the world. Approximately 200 plant and 80 seed lot accessions have been obtained from among five species of Cynodon. This material will be studied in a space-planted nursery to estimate genotypic variability for several plant characteristics. Information obtained will form the basis for deciding which breeding procedures may best be used to effect improvement.

2. Performance of forage bermudagrass varieties during year of establishment.

During the year of establishment, forage yields were not greatly different for Arizona common, Coastal and NK-37 when harvested as pasture or hay. Suwanee and Ga. 4-30 were slow to become established. Greenfield was low yielding under Arizona conditions.

The average nitrate accumulation in the eight forage bermudas tested did not exceed one percent at nitrogen fertilizer applications up to 800 pounds of N per acre per year.

15. FIELD CROPS RESEARCH IN NORTHERN ARIZONA.

Project Number: 503. Funds: State. Personnel: M. A. Massengale, T. C. Tucker, R. E. Dennis, R. L. Voigt, Alvin Allen and A. H. Underwood. (In cooperation with Departments of Agricultural Chemistry and Soils and Plant Breeding, and Agricultural Extension Service.)

An establishment study of alfalfa was conducted in Chino Valley. Ranger and Lahontan alfalfa were seeded alone and with oats as a companion crop. Oats were seeded at 25, 50, 75, 100, and 125 pounds per acre. Stand counts revealed that more plants were obtained when alfalfa was seeded alone than when seeded with a companion crop, although this difference was not significant. There was also no difference in total yield of alfalfa during the year of seeding when seeded alone and with a companion crop.

A cooperative experiment was conducted with Dr. T. C. Tucker on timothy fertilization. Nitrogen fertilization significantly increased the height of plants and yield. Split applications were more effective than single applications. Protein content of the forage was also increased by nitrogen fertilization. There was no response to phosphorus, however.

A barley variety test in Chino Valley indicated Arivat to be the highest producing variety.

Colorado White was the highest yielding variety in an oat test. Markton was the only variety to show symptoms of yellow dwarf, while Rodney was the latest maturing.

Variety tests were also conducted on both corn and sorghum for silage at Snowflake. Pfister 485 and 715 were significantly higher producing than Funks G-91--the commonly used variety. Sorghum tests showed that both NK 145 and NK 300 were significantly higher producing than Dual.

16. CROPS RESEARCH ON FARMS IN THE WELLTON-MOHAWK VALLEY.

Project Number: 506. Funds: State. Personnel: E. B. Jackson. (In cooperation with Departments of Agricultural Chemistry and Soils and Plant Breeding.)

Field crops research in this project is conducted in cooperation with farmers in the Wellton-Mohawk area. The experiments are conducted on cooperating farmers' fields. Seven experiments were completed in 1959.

Safflower grown on beds and on the flat yielded approximately the same from all row widths up to 30 inches; at 40-inch row spacings, yield was reduced. Several varieties from the Arizona safflower breeding program were superior to Gila in yield of seed.

Male sterile sorghum with RS-610 as pollinator planted March 11, 1959 set seed at Roll. Later plantings failed to set seed.

RS-610 was the high yielding variety of grain sorghum and 50 pounds of nitrogen gave the maximum yields in a variety and fertility experiment. None of the grain sorghums grown on saline soil were outstanding in salt tolerance.

Palestine oats, Ramona 50 wheat and Arivat barley were the highest yielding varieties of small grains at Roll.

The cotton variety test at Roll should be repeated due to variability which overshadowed varietal differences that may have existed.

Department of
ANIMAL PATHOLOGY

1. RANGE LIVESTOCK LOSSES FROM POISONOUS PLANTS.

Project Number: 171. Funds: Hatch and State. Personnel: W. J. Pistor, R. E. Reed, R. J. Trautman, C. T. Mason, Jr.

Percent nitrate was analyzed in 240 samples of blue panicgrass in different stages of maturity all receiving 800 pounds per acre of nitrogen. In the head stage means ranged from 0.591 to 2.144 percent nitrate. In the pollen stage means ranged from 0.809 to .891 percent and in the seed stage from 0.891 to 1.866 percent nitrate.

Nitrate percent as affected by soil moisture stress was analyzed in sixty-four samples of blue panic grass. Fertilizer amounted to 500 pounds per acre of nitrogen. Moisture stress was measured at depth of 6, 12, 18 and 24 inches. Means at the six-inch level ranged from 0.588 percent to 0.975, at the twelve-inch level from 0.475 to 0.825 percent, at the eighteen-inch level from 0.525 to 0.875 percent and 0.525 to 1.113 percent at the twenty-four inch level.

One hundred and fifty-three nitrate determinations were done on eight varieties of bermuda grass which was pasture and hay harvested during July and August of 1959. The varieties of bermuda grass tested were: Arizona Common, Coastal, NK-37, Cruz GA. 4-30,Suwanee, Midland and Greenfield. Nitrogen was applied at the 0, 200, 400 and 800 pound level per acre. Nitrate levels in the pasture-harvested samples ranged from 0.1 percent where no fertilizer was applied to 1.10 percent at the level of 800 pounds of total nitrogen in per acre. Average nitrate levels at the 0 nitrogen level ranged from 0.15 percent to 0.37 percent, at the 200 pounds per acre level from 0.25 to 0.55 percent, at the 400 pound level from 0.37 to 0.68 percent, at the 800 pound level from 0.30 to 0.70 percent nitrate.

During the period from July 30 to August 13 daily morning (8:00 a.m.) and afternoon (1:00 p.m.) samples of pigweed were taken from a particular patch of Amaranthus palmeri and analyzed for nitrates. The average morning sample was 6.0 percent nitrates as compared to the average afternoon sample of 4.2 percent nitrates.

Fifty-six plant samples were submitted to this laboratory by ranchers and farmers for nitrate analysis. Amaranthus palmeri, Russian thistle, and Franseria were the plants most commonly received. The nitrate levels in pigweed ranged from 0.10 to 7.0 percent, in Russian thistle from 1.55 to 7.90 percent and in Franseria from 0.50 to 1.15 percent nitrate.

Available nitrogen in the soils influences the nitrate storage in the plants. Nitrate storage in plants is greater in the morning than in the afternoon. Nitrate storage is increased in similar plants growing in the shade over those growing in the sunshine.

Attempts will be made to develop an acceptable method for determining the methemoglobin values in the blood.

2. INFECTIOUS KERATITIS IN CATTLE.

Project Number: 199. Funds: Hatch and State. Personnel: W. J. Pistor, R. J. Trautman and N. W. Rokey.

Staphylococcus-Streptococcus bacterin as a preventive for infectious keratitis was used on two purebred Hereford herds of 140 head of heifers and cows. There was no indication of increased resistance over the controls.

Control methods are again directed against the use of too many local treatments. Proper management with no treatments except for severe cases causing blindness are recommended.

This project is relatively inactive because of lack of sufficient personnel and equipment to enlarge the amount of study. We plan to continue the studies in a restrictive manner.

3. DIAGNOSTIC LABORATORY SERVICE.

Project Number: 339. Funds: State. Personnel: W. J. Pistor, R. E. Reed, N. W. Rokey, L. W. Dewhirst, R. J. Trautman, and H. G. Erling.

Diagnostic laboratories: Located in Tucson and Mesa.

Bacteriology, Parasitology, Serology, Necropsy, Toxicology, Histopathology, and Hematology studies.

Plant	693
Bovine	16,000
Equine	134
Swine	39
Ovine	10
Poultry	10,096
Milk and Water	300
Semen	25
Canine	56
Miscellaneous	790
Total	28,143

Ambulatory calls to Farm (Health supervision of University herds)

Disease control tests and vaccination	1,506
Reproductive problems	258
Surgery and treatments	180
Total	1,944

Services to industry. Arizona does not have another laboratory or State Department of Agriculture to render this diagnostic service.

Continued services with trend to more research.

4. HEMCGLOBINURIA IN PASTURE-FED AND RANGE CATTLE.

Project Number: 397. Funds: Hatch and State. Personnel: W. J. Pistor, N. W. Rokey, R. J. Trautman.

Work on this project has been restricted to diagnosis using both the capillary tube agglutination tests and to pathological studies using the silver stains. Attempts have been made to evaluate the values of bacterin vaccinations following a definite diagnosis.

Two hundred fifty-three blood serums were tested for leptospiral agglutinins. Forty-nine, or nineteen percent, showed a titer of 1:40 or better and were considered as positives. Living leptospira were seen in a bovine urine sample submitted to the laboratory for darkfield examinations.

Vaccination may be of value in endemic areas on new additions to the herd. Management of cattle grazing on lush forage high in protein still controls most cases. Cattle on balanced rations are not as susceptible to the disease as those on green pastures.

Studies involving the sylvatic and ecological aspects of leptospirosis will be resumed with the acquisition of a continuous flow high speed centrifuge.

5. INTERNAL PARASITES IN RANGE, PASTURE, AND FEEDLOT CATTLE.

Project Number: 422. Funds: Hatch and State. Personnel: L. W. Dewhirst, W. J. Pistor, and R. J. Trautman.

A total of 1932 bovine fecal samples were submitted to this laboratory during the reporting period. Each sample was examined (using a modified Lane technique) to determine the presence of ova of internal parasites. The average egg per gram (EPG) count of all samples was 118. When divided into three groups of range, pasture, and feedlot cattle, the average EPG counts were distinctly different. The average EPG count of 1067 fecal samples from cattle maintained on the range was 71. An average EPG count of 171 was obtained from 832 feedlot cattle while 24 pasture cattle revealed an average of 349 EPG.

While the average EPG counts of the groups as mentioned varied slightly from the values obtained from similar groups during the previous reporting period, the relative positions remained the same.

Normally, the most important parasites in Arizona cattle from the point of numbers belong to the Genus Cooperia. An occasional herd of cattle maintained on irrigated bermuda grass pastures revealed a numerical preponderance of Haemonchus sp. ova. It appeared, from observations of herds infected with a heavy population of one or the other of these genera of parasites, that Haemonchus sp. was by far the most pathogenic.

A comparison of the EPG counts between yearling bulls and heifers maintained on the range showed a definite difference. The average EPG counts of the bulls in three separate and similar herds was consistently and markedly higher than the average EPG counts of the heifers.

In two separate anthelmintic tests utilizing a total of 260 feedlot cattle, a topical spray of one gallon of 0.5 per cent CoRal, one 15 gram bolus of Trolene per 300 pounds of body weight, or 50 milligrams of Ruelene per kilogram of body weight (fed in the feed over a five day period) all significantly reduced the average EPG count for at least 90 days after treatment when compared to infected, untreated control animals.

Results should serve to impress the producers of the normally insidious nature of internal parasites and to help pinpoint areas of greatest danger, e. g., irrigated pastures. Anthelmintic studies should help in the ever present search for new and effective therapeutic materials.

Research will be continued to determine the relative abundance of various parasites in Arizona range, pasture and feedlot cattle. Observations will be continued to determine if an actual sex difference in worm burden occurs between yearling bulls and heifers. At least two tests will be conducted to determine the efficacy of two marketable anthelmintics of promise.

6. COCCIDIOIDOMYCOSIS IN ANIMALS.

Project Number: 439. Funds: State. Personnel: R. E. Reed, R. J. Trautman, R. H. Diven, K. T. Maddy.

Pathogenesis experiments started in 1957 and drug trials started in 1958 were completed. Treatment of additional dogs with intravenous amphotericin B did not alter results listed in the 1958 report. Blood levels of amphotericin given intravenously were at high in samples taken 48 hours after treatment as in samples taken 24 hours after treatment. Dogs treated by this route fared better than those treated by intramuscular injection, and better than the infected, untreated controls, but lesions containing viable organisms were plentiful at necropsy.

A grant request for continued support from NIH was approved, permitting employment of Dr. Diven as biochemist. Metabolic studies of the mycelial phase of the organism inactivated by acetone drying are planned. An attempt will be made to identify the metabolic pathways that are functional in this phase of the organism and to determine what tissue enzyme systems are altered in the infected animal. Coccidioides immitis isolates are being collected and will be screened for virulence and antigenicity in anticipation of vaccination experiments.

7. NEMATODE PARASITES OF RUMINANTS--ARIZONA CONTRIBUTING PROJECT LONGEVITY OF INFECTIVE LARVAE AND QUANTITATIVE DIAGNOSIS OF BOVINE NEMATODIASIS.

Project Number: 462. Funds: Hatch and State. Personnel: L. W. Dewhirst, R. E. Reed, and R. J. Trautman.

Survival of infective larvae of various bovine nematodes was markedly different when subjected to varying natural ecological conditions occurring at different altitudes in Arizona. This was determined by placing fresh bovine fecal material containing known numbers of nematode ova in isolation rings in three different ecological situations and studying the percentage development and longevity of the infective larvae.

The predominant factor in the development and survival of infective bovine nematode larvae in Arizona appears to be the amount of available moisture and the length of time it is available. High temperatures, while undoubtedly lethal in the absence of moisture, are apparently conditioned sufficiently if moisture is available for extended periods to allow for larval development and some survival.

Under conditions occurring during 1959, (the winter, spring and early summer were exceptionally dry) some larvae were viable in a grassland area at 3700 feet elevation for 11 months after being placed in the isolation rings.

Ostertagia sp. and Trichostrongylus sp. larvae were capable of developing and surviving under a wider range of ecological conditions than other larvae tested. Under optimum conditions, Cooperia punctata or pectinata and C. oncophora larvae developed and survived in greater numbers than other nematode larvae tested.

A comparison of the modified Lane direct centrifugal method of conducting egg per gram (EPG) counts using a zinc sulfate flotation solution with the Stoll dilution method revealed that the former yielded more consistent results.

Studies on survival will serve to illustrate that many infective larvae of bovine nematodes are extremely resistant to detrimental ecological conditions. It should also cast grave doubts on the value of short term pasture rotation under non-irrigated conditions for the specific purpose of controlling internal parasites.

Studies will be continued on the development and survival of infective larvae at 3700 and 9500 feet elevation under non-irrigated conditions and at 2500 feet in an irrigated, bermuda grass pasture. In addition, tests will be conducted to determine the reliability and efficiency of other currently used methods of conducting EPG counts.

8. STUDIES ON BEEF MEASLES.

Project Number: 475. Funds: State. Personnel: L. W. Dewhirst, W. J. Pistor, R. E. Reed, R. J. Trautman.

During the early part of 1959, 499 head of crossbred steers which were suspected of being infected with beef measles (Cysticerci of the human tapeworm, Taenia saginata) were skin tested by injecting one-tenth cubic centimeter of an aqueous extract of a dried adult tapeworm intradermally. In each instance the antigen used was diluted 1:500 with saline. Reactions were read at 30 minutes to one hour later and considered to be positive if the size of the induration exceeded three centimeters.

A total of 69 were called positive on the basis of the skin test and 430 as negative. When slaughtered and examined, no animals in the negative group were found to harbor cysts. In the positive group, on initial inspection only four animals were found to have viable cysts but on closer inspection the federal inspector reported that "Quite a few had old calcified cysts in the heart."

Five adult human tapeworms were received and identified. One proved to be Taenia solium while the remaining four were Taenia saginata.

Efforts to infect two additional calves with beef measles were unsuccessful presumably because of the non-viability of the tapeworm ova used.

Antemortem diagnosis while not yet possible would seem to be a definite possibility. Such a tool, while probably not routinely used, would have application where infections have occurred or are suspected of having occurred.

Emphasis in future work will be on attempting to perfect an antemortem diagnostic test, reactions of diagnostic procedures to graded infections, persistence of positive reactions to a single exposure, and to determine the in vivo efficacy of several promising therapeutic agents.

9. PRELIMINARY STUDY OF THE ETIOLOGY OF MORTALITY OF YOUNG CALVES.

Project Number: 476. Funds: State. Personnel: N. W. Rokey and H. G. Erling.

One hundred sixteen dead and dying calves from 48 herds were studied. Histories, clinical signs, necropsy lesions, bacteriological and histopathological findings were recorded. Salmonella species were isolated from 54 or approximately 48% of the total calves examined. Other isolations were as follows: Coliforms, 12%; Pseudomonas spp., 10%; Proteus spp., 10%; Coliform-Proteus spp., 7%; and Pseudomonas-Proteus, 2%.

In study of prenatal infections, forty-two aborted feti were examined. Organisms isolated were: Brucella spp., Streptococcus spp., Salmonella spp., Listeria spp., Proteus spp., and coliforms.

In an attempt to correlate death loss of young calves and possible preconception infections, samples of raw and frozen bull semen were studied. Organisms isolated were coliforms, Proteus spp., Pseudomonas spp., Staphylococcus and Streptococcus.

Etiology of calf mortality due to salmonelloses is significant. Since these bacteria are associated with filth, sanitation and management are probably the most important means, presently known, of prevention and control of infections.

High incidence of salmonella organisms in calves is of public health signifcance and represents a potential dangerous reservoir of infection for man.

Survey of calves, aborted feti, and semen will be continued. Initial studies of chemotherapeutic agents and evaluations are anticipated.

10. PILOT STUDIES - SALMONELLA DUBLIN.

Project Number: 481. Funds: State. Personnel: N. W. Rokey, H. G. Erling, and V. N. Snell.

Salmonella dublin was first encountered in Arizona in 1958. Since that time, 14 S. dublin epizootics in calves have been held responsible for extremely high rates of calf mortality. S. dublin was isolated from 20% of all calves (116) examined. S. dublin was isolated from 21 of 37 (57%) calves in age group 15-90 days. Sporadic outbreaks have occurred in other species; poultry, seven; equine, two; dogs, two; and one each from mice, rabbits, and doves. Mortality in infected herds of calves was approximately 48%. Morbidity was approximately 65%. Heavy losses were also encountered in poultry.

An S. dublin rapid plate agglutination test is under investigation. One hundred sixty-nine (169) bovine sera were tested. Of 98 bovine sera of unknown history, 58 (57%) were positive in a dilution of 1:50 or higher. Of 63 bovine sera collected from known infected herds, 29 (46%) were positive in a dilution of 1:400. Results of six equine sera tested were not conclusive. A tube agglutination antigen has been prepared and is under investigation.

Investigations of carrier status in infected herds are now currently under investigation. Though not yet completely substantiated, there is sufficient evidence to indicate that S. dublin infections in dairy herds have been immediately preceded by importation of adult cows from known infected herds or areas.

The high incidence and apparent rapid spread of S. dublin in cattle is of interest to livestock owners and more particularly to livestock disease regulatory officials as well as Public Health officials.

Danger of spread of S. dublin by importation of cattle from known infected herds or areas can no longer be ignored.

Investigations will be continued as outlined.

11. PRELIMINARY STUDIES OF FOWL SPIROCHETOSIS (BORRELIA ANSERINA) IN ARIZONA POULTRY.

Project Number: 504. Funds: State. Personnel: N. W. Rokey, H. G. Erling, V. N. Snell, and J. M. Primrose, Jr.

Borrelia anserina, a bacterium capable of causing an extremely destructive disease of poultry, has been identified and assumed to be the etiological agent responsible for epizootics of fowl spirochetosis in central Arizona.

Mortalities of 10 to 40% have been observed in field outbreaks.

Clinical signs and necropsy lesions observed in both field epizootics and experimental test birds are indistinguishable from those of classical fowl cholera. Diagnosis of the disease may be made by stained blood slides and/or by dark field microscopy.

All attempts to grow the bacterium in artificial media have failed. The laboratory strain is maintained in susceptible test birds by serial passage. Attempts to transmit the disease by contact and by fecal material have also been unsuccessful. The exact mode or modes of transmission await further investigation.

Two hundred ninety-seven (297) experimental birds have been studied. Clinical signs, necropsy lesions have been recorded. Doves, pigeons, rabbits, and sheep were refractory to the infection.

The occurrence of Borrelia anserina in Arizona poultry is of particular interest. Serious losses could be experienced if this infection became widespread in Arizona poultry. Every effort should be made to eliminate infected flocks.

The similarity of this condition to fowl cholera firmly supports the importance of diagnosis of poultry disease at a qualified laboratory.

Attempts will be made to grow Borrelia anserina in artificial media. The organisms will be maintained in serial passage in the laboratory. An experimental antigen currently in process of development will be evaluated on experimental birds.

"Natural Occurrences of Borrelia Anserina (Fowl Spirochetosis) in Poultry." Manuscript.

12. CANINE BABESIOSIS.

Funds: State. Personnel: N. W. Rokey, H. G. Erling, V. N Snell, and J. M. Primrose, Jr.

Babesia canis, a blood protozoan of dogs, was identified and assumed to be the etiological agent responsible for Canine babesiosis, a vague disease entity of dogs. This disease is reported only infrequently in the United States. The organisms were transmitted to splenectomized and unsplenectomized dogs. Splenectomized felines were refractive as were unsplenectomized rabbits. The organism was transmitted to an unsplenectomized yearling ram which subsequently died with central nervous involvement.

The laboratory strain is maintained in an unsplenectomized dog inoculated at six weeks of age.

The brown dog tick, Rhipicephalus sanguineus, is generally considered to be the arthropod vector responsible for transmission of the disease.

Justification of these investigations is based on the similarity of this organism to Babesia bovis, the causative agent of Texas fever of cattle, and the recent identification of Babesia in a mule deer from the western border of New Mexico.

The occurrence of canine babesiosis may be more widespread than is generally accepted. Further study of this disease is justified to clearly delimit the condition to canines.

Further studies are anticipated to fully delimit canine babesiosis as a disease entity of dogs. Additional studies anticipated are attempts to clearly define the clinical signs, necropsy lesions, and acceptable method of diagnosis of the condition.

Rokey, Ned W. and Russell, Ray E.: "Canine Babesiosis - A Preliminary Report." Manuscript.

Department of
ANIMAL SCIENCE

1. INFLUENCE OF FORAGE HARVESTING AND FEEDING METHODS ON BEEF PRODUCTION.

Project Number: 248. Funds: Hatch and State. Personnel: E. S. Erwin, B. R. Taylor, C. B. Roubicek.

A study was conducted at the Yuma Experiment Station with 50 beef calves to evaluate as bloat prophylactics the following feed additions to an ad libitum diet of fresh, green-chopped alfalfa: (1) barley .9 lb./100 lbs. body weight (B.W.); (2) cottonseed meal .29 lb. plus a .61 lb. barley/100 lbs. B. W.; (3) whole cottonseeds .54 lb. plus .36 lb. barley/100 lbs. B.W.; (4) 12% tallow on barley fed at rate of .9 lb./100 lbs. B.W. and (5) 12% hydrolyzed vegetable oil on barley fed at the rate of .9 lb./100 lbs. B. W.

Fresh, green-chopped alfalfa has been found to result in a serious bloat problem in the Yuma area during previous years; however, no cases of bloat were observed during this trial.

Average daily gains for the respective treatments during the 91-day trial were: (1) 2.36 lbs., (2) 2.21 lbs., (3) 2.12 lbs., (4) 2.60 lbs., and (5) 2.13 lbs.

Previous work on this project has shown that the addition of fat to the ruminant ration is helpful in the prevention of bloat.

2. THE EVALUATION AND UTILIZATION OF LOW QUALITY ROUGHAGES AS FEEDS FOR LIVESTOCK IN ARIZONA.

Project Number: 388. Funds: Hatch and State. Personnel: E. S. Erwin, Farris Hubbert, Jr., N. G. Elliston, B. R. Taylor.

In vivo nutrient digestibility and rate of dry matter intake have been considered to be the most promising indicators of forage quality in terms of animal response. A rapid method for estimating forage digestibility was developed which consists of placing 20 gm. of the forage in a silk bag and attaching a series of bags to lead-filled, plastic-covered pipe. The series of bags is then placed in the anterior dorsal sac of the rumen of an animal fitted with a rumen fistula. Preliminary work indicated that a 9-hour digestion period was adequate for a reliable estimate of in vivo dry matter digestibility; however, further work is being done to determine the optimum time for digestion.

Four steers fitted with rumen fistulas were used in a comparison of the forage quality of alfalfa hay and barley straw. In vivo dry matter digestibility was determined by the lignin ratio, in vitro cellulose digestibility was determined with mixed suspensions of rumen microorganisms and dry matter digestibility was estimated by the silk bag technique. A high correlation was found between in vivo dry matter digestibility and in vitro cellulose digestion. Little relationship was found between in vivo dry matter digestion and dry matter digestibility as estimated by the silk bag technique.

The development of a rapid and reliable method for evaluating forage quality will be of great value to the producer. Such a research tool will aid in defining the factors that differentiate a high-quality from a low-quality forage.

3. FARM FLOCK SHEEP PRODUCTION ON SOUTHWESTERN IRRIGATED PASTURES.

Project Number: 403. Funds: Hatch and State. Personnel: O. F. Pahnish, C. B. Roubicek, B. R. Taylor, W. J. Van Arsdell, John Kuhn.

This project (as revised in 1959) has as its objectives the evaluation of returns from various flock management systems and the evaluation of therapeutic materials and altered management practices on breeding time and efficiency.

Fifty-seven ewes were exposed to rams during July and August 1959 and only two ewes (3.5 per cent) produced lambs as a result of the summer matings.

Eighty-one grade Rambouillet ewes were allotted at random to Rambouillet, Suffolk, Hampshire, and Columbia rams on October 6, 1959, and exposed for a period permitting four estrus cycles. Thirty-six crossbred ewes were allotted to Rambouillet and Suffolk rams for the same period. About 2.6 per cent of all ewes failed to receive service during the period described.

4. THE EFFECTS OF CLIMATIC AND NUTRITIONAL STRESSES ON GROWTH AND PRODUCTIVITY OF RANGE CATTLE.

Project Number: 411. Funds: Hatch, Regional Research, and State (W-46). Personnel: C. B. Roubicek, Farris Hubbert, Jr., R. E. Taylor, B. R. Taylor.

Lambs were used to determine if water consumption and retention could be altered by using caffeine. The 2x2 factorial study included two periods in which animals were subjected to a constant inside temperature and intermittent high outside temperature with and without caffeine injections. Results show that caffeine did not have a diuretic effect on the sheep. A careful study of the data shows the difficulty of using a single value for comparative purposes. Diurnal variation appears to be very pronounced for practically all factors studied.

A three-phase study was conducted to determine the relationships of feed and water consumption during high environmental temperatures. In trial I feed was constant with three levels of water available; in trial II feed was limited and water provided ad libitum; in trial III feed was constant but fed once, twice, or three times per day. The main effect noted was the marked increase in water consumption in trial III for the animals fed twice a day. Water consumption in trial II shows a direct relationship to feed consumption. Feed consumption in trial I was directly related to water consumption.

5. LEVELS OF ENERGY AND PROTEIN FOR SUMMER FEEDING OF CATTLE.

Project Number: 458. Funds: State and 2RC Boswell. Personnel: E. S. Erwin, Farris Hubbert, Jr., B. R. Taylor, C. B. Roubicek, John Kuhn.

Eighty steers were fed for 109-days (June 7 through October 4) at the Yuma-Mesa Experiment Station, to determine the influence of stage of maturity of alfalfa and the addition of either hydrolyzed vegetable oil or stabilized tallow to a growing-fattening ration. Only 0.9 lb. barley per 100 lbs. body weight per steer per day was fed in addition to an ad libitum feed of either pre-bloom or full-bloom alfalfa hay.

A slight advantage in rate of gain and feed conversion was found in favor of the pre-bloom hay. The addition of .75 lb. of hydrolyzed vegetable oil in place of an equal amount of barley resulted in a significant increase in rate of gain. There appeared to be no difference in response between stabilized tallow and hydrolyzed vegetable oil when they were compared on the pre-bloom alfalfa ration.

The gains made in this summer trail with the low-level of concentrates were both satisfactory and economical.

A low-concentrate ration can be used to produce economical gains during the period when high summer temperatures depress gains in feedlot cattle. It may be a better practice to make maximum utilization of a low-concentrate ration during the extremely hot part of the year rather than to feed a high-concentrate ration with poor performance and rate of feed conversion.

6. DEVELOPMENT OF SELECTION CRITERIA FOR THE GENETIC IMPROVEMENT OF CARCASS MERIT IN SHEEP.

Project Number: 484. Funds: Hatch, Regional Research, and State (W-61). Personnel: C. B. Roubicek, O. F. Pahnish, B. R. Taylor.

Thirty wether lambs were randomly divided into three groups of 10 lambs each. The lambs were placed in metabolism stalls for a 5-day total urine collection period prior to slaughter. Urine volume, urine pigment, and creatinine were determined. The lambs were then slaughtered and complete carcass data obtained. Specific gravity, grid photographs of cut surfaces, wholesale cut weights, and laboratory analyses for moisture, protein, and fat were obtained. Preliminary indications are that creatinine coefficient and specific gravity are of limited value in predicting carcass composition. Individual muscle size as shown in the grid photographs are now being studied.

7. A STUDY OF SEVERAL HORMONE-LIKE COMPOUNDS FOR FATTENING STEERS ON DRY LOT.

Project Number: 485. Funds: State. Personnel: E. S. Erwin, B. R. Taylor, W. J. VanArsdell, C. B. Roubicek.

Forty-eight steers were fed for 163 days, in replicated pens of 8 animals each, on a fattening ration containing alfalfa and rolled barley. Hormone-like substances studied were either implanted or mixed in a supplement fed at the rate of 2 pounds per animal per day, which contained: milo, dicalcium phosphate, urea, salt, and a trace of mineral premix.

The treatments studied during the 163-day period were: control, 24-mg. implant of stilbestrol, and 25-mg. 3-3-diallyl-hexesterol (3-3-D-H) fed per steer per day. The respective average daily gains were: 2.26, 2.57, and 2.37 pounds.

Another group of 96 steers were fed 83 days in the same manner as those described above. Treatments studied during this period were: control, 40 mg. implant of 3-3-D-H, 80 mg. implant of 3-3-D-H, 25 mg. implant of 3-3-D-H plus 15 mg. orally per day, and 25 mg. of 3-3-diallyl-stilbestrol orally per steer per day. The respective average daily gains were: 2.58, 2.57, 2.40, 2.41, and 2.28 pounds.

The results of the study indicate that the levels of 3-3-diallyl-hexesterol or 3-3-diallyl-stilbestrol implanted or fed will not equal the response expected from a 24-mg. implant of stilbestrol.

The value of the use of stilbestrol implants in the feedlot has been well established. This work indicates that the hormone-like materials studied hold little promise as replacements for stilbestrol as practical stimulators of feedlot gain.

8. BREEDING AND SELECTION OF BEEF CATTLE FOR THE SOUTHWEST.

Project Number: 500. Funds: Hatch, Regional Research, and State (W-1). Personnel: O. F. Pahnish, C. B. Roubicek, E. B. Stanley, Farris Hubbert, Jr., P. E. Lineberry, and graduate students.

A cattle breeding program in cooperation with the Apache Indian Tribe at San Carlos, Arizona, has been in progress since 1957. The purebred Hereford herd owned by the Apache Tribe is used in this program. Results during the past year are subsequently summarized.

1. Through a reduction in the area of breeding pastures to which individual sire complements are assigned, conservation of range forage for the breeding season and three months immediately prior thereto, semen evaluations before the breeding season, and elimination of shy-breeding cows, the calving percentage (calculated at end of calving season) increased as follows:

Year	Calving Percentage
1957	68
1958	74
1959	82

2. Concentrations of vitamin A and carotene in the blood plasma at weaning time and at about 12, 18, and 24 months of age were not adequate indicators of the amount of vitamin A and carotene stored in the liver.

3. As indicated by chemical analyses of the liver samples, the stores of liver vitamin A in animals up to two years of age were never dangerously depleted. The cattle were on range forage without vitamin A supplement.

4. Preliminary estimates of the heritabilities of liver and plasma vitamin A and carotene concentrations determined by the paternal half-sib method, are recorded in the following table. Separate estimates were calculated from the data on bull and heifer progeny.

	Bull		Heifers	
	Weaning	12 mo.	Weaning	12 mo.
Liver vitamin A	0.44	0.20	0.72	0.21
Liver carotene	0	0.14	0.35	1.32
Plasma vitamin A	0	0	0.25	0.06
Plasma carotene	0.13	0.52	0.28	0.26

9. VITAMIN A AND CAROTENE UTILIZATION IN DEFICIENT RUMINANTS.

Funds: 2RC Vitamin A (Public Health Service). Personnel: E. S. Erwin, B. R. Taylor, H. M. Page, Jr., R. H. Diven, T. R. Varnell, C. B. Roubicek.

The influence of protein supplementation on the utilization of intravenously injected carotene and vitamin A by cattle on a carotene deficient ration was studied. The injected carotene did not influence hepatic vitamin A storage. Only a slight difference in hepatic vitamin A storage was found between protein adequate and deficient animals where vitamin A was injected. Other studies indicated that oral administration of several sources of vitamin A resulted in an elevation of plasma carotene. It was also found that hepatic storage of vitamin A and carotene is inversely related to initial storage of these nutrients.

Previous work has shown that animals on a carotene deficient diet, such as mature range forage, cannot efficiently utilize carotene as a vitamin A source. Information on the possible influence of protein deficiency on carotene and vitamin A metabolism by the ruminant holds special interest with regard to the practical problems of the range livestock industry as well as adding to the basic knowledge on the metabolism of carotene and vitamin A.

10. EFFECT OF DIETARY PROTEIN AND FAT ON LIPO AND SERUM PROTEINS IN STEERS.

Funds: State. Personnel: T. R. Varnell, Farris Hubbert, Jr., C. B. Roubicek, B. R. Taylor.

Eighty steers, fed a growing - fattening ration consisting of .9 pound of barley per 100 pounds body weight and either pre-bloom or full-bloom alfalfa hay, were bled at the end of a feeding study. Fat treatments imposed on the two hays were: control, stabilized tallow, and hydrolyzed vegetable oil. Serum proteins and lipo proteins were separated electro-phoretically to determine the possible influence of dietary fat on the serum fractions.

The dietary treatments appeared to have no influence on the serum protein fractions.

The addition of either stabilized tallow or hydrolyzed vegetable oil resulted in a significant shift of lipo protein from fraction IV to fraction I. The Physiological significance of this is not apparent at the present time. There was also a tendency for increased serum cholesterol concentration in the serum of steers fed either fat source.

The results of this work contribute to the store of knowledge being accumulated on factors influencing serum protein and lipo-protein content of ruminants. It is visualized that these data may have importance in elucidating the factors involved in transport, storage, and utilization of vitamins such as vitamin A.

11. THE VALUE OF WISYME AND MALT AS A SUPPLEMENT TO CATTLE RATIONS.

Funds: 2E&G Wisconsin Malting. Personnel: E. S. Erwin, B. R. Taylor, J. R. LeGendre.

The value of the addition of barley malt enzyme preparation (Wisyme, produced by the Wisconsin Malting Company) to ruminant rations containing barley or milo was studied. In vitro fermentation studies conducted with mixed suspensions of rumen microorganisms in macro Warburg flasks and grain in the rumen of fistulated steers in silk bags indicated that the enzyme preparation depressed rumen microorganism activity.

Forty-eight steers weighing approximately 700 pounds were allotted to 6 pens. The following treatments were randomly allotted to replicated pens: control, 1% Wisyme, and 2% Wisyme. All animals were fed a ration containing 50% barley, 25% alfalfa, 25% Bermuda straw, and 2 pounds of supplement per steer per day. There were no significant differences found in rate of gain at the end of the 84-day feeding period.

There has been considerable interest in the possible value of enzyme preparations to ruminant rations. This work indicates that a barley malt enzyme preparation does not enhance the value of a ruminant ration containing barley.

12. INFLUENCE OF IMPLANTED STILBESTROL ON RATE OF GAINS OF RANGE AND FEEDLOT CATTLE.

Funds: State. Personnel: C. B. Roubicek and B. R. Taylor.

Hereford steers were subjected to several combinations of stilbestrol implants, starting at approximately 2 months of age and continuing through the feedlot. Stilbestrol implant treatments included: none, pre-weaning, weaning, yearling and feedlot plus combinations of these with some steers receiving four implants. In addition, the feedlot phase included feedlot response to oral stilbestrol of previously range-implanted steers.

All range implants, except the weaning implant alone, produced significantly greater weight gains than did the control treatment of no stilbestrol. There were no apparent adverse effects from range implants of stilbestrol under the conditions of this trial.

Steers that received a 24-mg. feedlot implant gained significantly more than did the control steers or those fed 10 mg. of stilbestrol per head daily. The various range stilbestrol treatments prior to the feedlot period had no significant effect on feedlot gain regardless of feedlot treatment.

Carcass grade was not influenced by treatment; however, feedlot-implanted steers produced carcasses with a significantly larger rib-eye area than did the control steers or those fed stilbestrol.

13. THE RELATIONSHIPS OF URINARY CREATININE EXCRETION TO CARCASS COMPOSITION OF WETHERS.

Funds: State. Personnel: C. B. Roubicek and graduate student.

Urinary creatinine excretion was obtained from 30 wether lambs placed in metabolism stalls. After a five day collection period they were slaughtered and carcass cut-out values were determined.

The variations in creatinine excretion appear to be independent of urine volume or carcass protein mass. On the basis of results obtained, creatinine excretion is of very limited value in predicting protein mass or cut-out percentages. The wholesale shoulder is a representative part of the entire carcass.

Department of
BOTANY

1. INVESTIGATIONS ON THE STOMATAL MECHANISM.

Project Number: 385. Funds: Hatch and State. Personnel: Robert M. Harris.

Laboratory experiments have demonstrated that the stomates of albino and carotinoid corn seedlings open when air of low CO_2 concentration surrounds the leaves.

Studies on corn, geranium, colues and mesquite leaves show that the internal temperature of these leaves increases as transpiration in full light decreases.

Measurements of transpiration on mesquite and acacia leaves indicate that these desert plants lose water at approximately the same rate as has been reported for some mesophytes.

Field and laboratory experiments on the saguaro show that these plants, contrary to current literature, have the usual transpirational pattern.

The work done in the past few years on mutant and normal corn plants corroborates the photosynthesis-respiration relationship of stomatal behavior.

2. ROOT DEVELOPMENT OF FORAGE CROP SPECIES AS INFLUENCED BY PHYSICAL AND CHEMICAL FACTORS OF THE SOIL.

Project Number: 427 (W-47). Funds: Regional Research. Personnel: W. S. Phillips and Susan H. Lee.

In vitro culture work has been carried on as planned. For this year all work was concentrated on developing methods of growing monocot roots. Very little success has been recorded in the literature with monocot roots and this seemed to be an excellent chance for basic research on a group of plants extremely important to agriculture.

The following solutions and variations were attempted: (1) White's solution and modifications, (2) buffered solutions pH 5 to 7.5 and variations, (3) Lactose substitution for sucrose, (4) Epicotyl extract, and (5) Coconut milk, (6) L-tryptophane, and (7) indoleacetic acid.

Two types of Sudan grass were selected because of their importance in arid lands. Standard procedures for in vitro culture were followed similar to those used for alfalfa roots which were grown successfully in vitro.

3. SOME ENVIRONMENTAL REQUIREMENTS OF CANDELILLA, A POTENTIAL WAX PLANT FOR THE SOUTHWEST.

Project Number: 498. Funds: Hatch and State. Personnel: Edwin B. Kurtz.

Nutrient culture experiments in which pH level and the concentration of iron and minor elements are varied are now underway. In addition a macro nutrient deficiency series is being prepared. These experiments are designed to provide information about the nutrition of candelilla. No results are yet available.

4. METHODS AND APPLICATION OF POLLEN ANALYSIS IN THE SOUTHWEST.

Funds: Non-Federal. Personnel: E. B. Kurtz, R. Komerska, J. S. Tarr, and H. Tucker.

Work on the pollen analysis of soils from two archaeological deposits is continuing. A statistical analysis of modern corn pollen has provided knowledge about the problems of identification of fossil corn pollen.

5. THE USE OF FATTY ACID ESTERS OF SUGARS IN PESTICIDE SPRAYS (NATIONAL RENDERERS' ASSOCIATION).

Funds: Non-Federal. Personnel: E. B. Kurtz and J. McCarthy.

Samples of fatty acid esters of sucrose differing as to chain length and degree of unsaturation of the fatty acid have been prepared. These are to be tested by the bean curvature test, fluorescent dye tests for penetration, and autoradiographic studies using a radioactive herbicide. From these studies it is hoped to evaluate the esters with regard to effect on herbicide penetration and translocation.

6. THE PROPAGATION OF CANDELILLA AND A STUDY OF THE SYNTHESIS OF WAX IN PLANTS (S. C. JOHNSON AND SON).

Funds: Non-Federal. Personnel: E. B. Kurtz and K. Matsuda.

Studies on propagation are reported under Hatch 498. Studies on the synthesis of wax in plants are continuing and will be summarized this year in a doctoral thesis by K. Matsuda. In vitro studies on wax synthesis are now in progress.

This project is intended to provide basic information about plant waxes. These findings should have indirect application to pesticide penetration studies.

7. THE UNIVERSITY OF ARIZONA HERBARIUM, STATE PROJECT #327.

Funds: Non-Federal. Personnel: Charles T. Mason, Jr.

The growth and development of The University of Arizona Herbarium continued. To the herbarium were added 4615 specimens. Exchange with other institutions involved the shipping of 1903 specimens and the receipt of 956. Loans to other institutions continued and 868 specimens were sent out during 1959. The total is 1615 specimens outstanding. We in turn have on hand 1278 specimens borrowed from other institutions, and during the year returned 842 specimens.

In addition to the identification of specimens for the departments of Bacteriology, Animal Pathology, Plant Pathology, Horticulture, Animal Science, Entomology, and Zoology, and the College of Pharmacy, identification and information for 548 specimens were furnished to tourists and residents of Arizona including County Agents.

8. A STUDY OF THE RELATIONSHIP BETWEEN THE PERENNIAL GENTIANA OF THE SECTION PNEUMONANTHE.

Funds: Non-Federal. Personnel: Charles T. Mason, Jr.

The title of this project has been revised to include perennial members of the Pneumonanthe section of the genus Gentiana, because the studies undertaken to date under a N.S.F. grant have indicated the necessity of broadening the field.

A third collecting trip was made during August to obtain species not already collected, to obtain more field data, and to obtain illustrations of the several species.

The attempts to raise gentians in the greenhouse have been dropped because of the difficulties of controlling conditions, and because of the high mortality of plants.

9. PHYSIOLCGICAL GENETIC STUDIES ON STATURE MUTANTS OF MAIZE.

Funds: Non-Federal. Personnel: Robert M. Harris, Mary Elberfeld, Albert T. Ellis, Robert Hall, Mac D. Homan and William O'Donald.

Studies on the four different single-gene stature mutants of maize, 4963, d_1, Nana-1 and Nana-2 indicate that their dwarfism in each instance involves a different physiological mechanism.

Anatomical studies of dwarf 4963 show that the embryo of the mutant differs in size from that of the normal sib. Such differences have not been observed between other maize dwarfs and their normal sibs.

Chromatography of ether-soluble extracts of the coleoptiles of d_1 stature mutants and the corresponding normal structure indicates that IAA is not the native auxin in these plants. Auxin increase in gibberellin-treated d_1 seedlings may involve a substance or substances other than IAA.

Anatomical and physiological studies of Nana-1 and Nana-2 are underway with preliminary findings indicating that two different physiological mechanisms exist for their dwarfism.

Studies on these mutants should prove valuable in elucidating the genetic control of the physiology of dwarfism and the interrelationship of auxins and gibberellins.

10. VEGETATIONAL CHANGES - GREAT PLAINS (GRASSLANDS, USA) 2RC ONR.

Funds: Non-Federal. Personnel: W. S. Phillips and Freeman Smith.

Last June an attempt was made to complete the work started by H. L. Shantz on the Great Plains. Freeman Smith and chief investigator were able to rephotograph 120 locations out of a possible 250 locations previously picked as possibilities. In 1958 up to Dr. Shantz' death we had relocated 72 locations. Dr. Shantz picked 438 possible locations and the 192 we have found will be supplemented by another 50 this summer. During the year we have mounted these photographs and written up results. Ninety percent of the photographs show more forest now than

Human interference with vegetation is evident, but usually of a beneficial nature. In general the land is in better condition now than past photographs show.

11. THE SYNTHESIS OF FATTY ACIDS IN A HIGHER PLANT (USAEC).

Funds: Non-Federal. Personnel: E. B. Kurtz, Leslie Smith and Abdul Wahab.

The work of others and ours has shown that biotin is required for the synthesis in plants and animals of long chain fatty acids. We have now shown that the biotin required by flax seed embryos for fatty acid synthesis is not made by the embryos. Rather the biotin is formed in the fruit wall and then is moved to the embryos. Biotin therefore appears to be a hormone whose arrival in the embryo triggers the synthesis of specific fatty acids. Work is underway to determine the role of light in fatty acid synthesis. White light of low intensity stimulates fat synthesis in the embryos, but darkness stimulates carbon dioxide evolution. No mechanism of action is yet available, although it appears to be related to photosynthetic phosphorylation.

12. STUDIES ON THE PHYSIOLCGY OF THE SAGUARO CACTUS.

Funds: Non-Federal. Personnel: E. B. Kurtz and Stanley Alcorn and others.

Studies on the physiology of seed germination and pollination have been summarized in print. Other work is in progress on the nutrition of the saguaro, but no conclusions have been reached.

13. NUTRITION OF SORGHUM.

Funds: Non-Federal. Personnel: Edwin B. Kurtz and R. H. Maier.

It has been shown that the variety of Sorghum, Double Dwarf-38 grows best in alkaline nutrient media and shows severe symptoms of iron chlorosis in neutral or acid media. Analysis of plants grown on pH's from 3 to 10 for iron shows that iron accumulation below pH 7 is markedly diminished.

Department of
DAIRY SCIENCE

1. THE EFFECT ON MILK PRODUCTION OF FEEDING A COMPLETE PELLETED RATION TO DAIRY COWS.

Project Number: 423. Funds: Hatch and State. Personnel: R. G. Fossland.

Alfalfa obtained in the Casa Grande area in October, 1959 was cut in the early bloom stage, windrowed, field chopped as processed into blocks weighing approximately 50 pounds with the addition of about 5% molasses, in three degrees of fineness as follows: (1) "Coarse," run through a hammer mill without knives or screen, (2) "Medium" run through a hammer mill without screen, and (3) "Fine" run through a hammer mill with a 3/4" screen. These materials of different fineness were fed as the sole roughage to three groups of lactating Holstein cows, together with appropriate amounts of regular herd grain mixture, fed according to milk production, on a reversal type feeding trial. Cows were fed individually in mangers and kept between milking and feedings in a corral with access to water. The purpose of this trial was to attempt to find a degree of coarseness of grind which would not depress fat percentage, when used as a sole roughage. Difficulty was experienced in getting cows to consume sufficient amounts of this material to maintain expected body weights and milk production on twice-a-day feeding even when additional water was offered to the cows by pail or sprinkled on the roughage. Considerable variation in fat percentage was observed among cows fed all three degrees of coarseness, a few cows maintained fat percentages within normal degrees of expectation. Four of the 18 animals that started the trial were lost during the course of the trial for health reasons which makes meaningful statistical analysis difficult.

2. MOBILIZATION AND ABSORPTION OF CALCIUM AND PHOSPHORUS BY CATTLE.

Project Number: 446. Funds: Hatch and State. Personnel: V. R. Smith, G. H. Stott, and J. D. Fleming.

I. Mature normal cows were injected intravenously with the disodium salt of ethylenediamintetraaectic acid at a given rate per 100 lbs. of body weight. The cows generally showed tetany after about 2 1/4 hours of slow injection (7 to 9 ml. per minute) of the chelating agent. The calcium level at tetany was between 5.7 and 6.3 mg. percentage. The blood serum calcium obtained preinjection levels at about 21 hours. The same cows on which patterns of calcium mobilization rates were established were subjected to thyroparathyroidectomy. In post-operative chelations at 21 days, the preinjection level was lower and the cows went into tetany at a higher calcium level than prior to the operation. Preinjection levels were attained at a shorter time after chelation than before the operation. At 110 days post operation the calcium levels were markedly lower than before and the cows showed tetany at a much lower serum calcium level than before the operation. Preinjection levels of calcium were attained at six hours post injection. Bone biopsies were also made on these cows pre- and post-operative. The bone ash weight as a percentage of the dry matter was considerably greater after thyroparathyroidectomy than in the normal animal.

II. THE PARATHYROID IN MILK SECRETION AND REPRODUCTION.

Four heifers and one mature lactating cow were thyroparathyroidectomized. Following the operation all conceived with no indication of abnormality. At 90 days pregnancy, two of the animal showing severe symptoms of low serum calcium, aborted. The rest of the animals, showing only slight symptoms, carried their calves to term. Parturition occurred without incident. All the animals have been bred back the second time.

As controls, two heifers and one cow were thyroidectomized only. All showed normal reproductive behavior on breeding. Milk production in the thyroidectomized animals seemed to be normal, all producing between 30 and 40 lbs. per day. The thyroparathyroidectomized heifers on the other hand had limited secretion, (6 to 12 lbs. per day). On treating them with a thyroid substitute (protamone) milk production increased but never approached the controls. Complete analysis of the milk (for calcium, phosphorus, protein, fat and lactose) indicated the level of the different constituents to be normal. Controlled intake of calcium and especially phosphorus in the parathyroidectomized animals indicated the importance of these two minerals in regulating milk secretion.

3. THE VITAMIN A AND CAROTENOID CONTENT OF THE LIVER AND BLOOD PLASMA OF DAIRY CATTLE SHOWING VITAMIN A DEFICIENCY SYMPTOMS.

Project Number: 447. Funds: Hatch and State. Personnel: V. R. Smith and J. D. Fleming.

This work was continued in much the same manner as the previous year. Both Vitamin A and Carotene were infused intravenously and orally. Carotene does not seem to be utilized very effectively by the newborn. Liver biopsies of the calves showed that there was considerable difference in the Vitamin A content of liver at different sites. There appeared to be no great difference in the utilization of Carotene by the newborn. Vitamin A was much better utilized by the young ruminant.

4. HIGH-ENERGY LOW-FIBER FEEDS. IMPROVING PRODUCTIVE AND REPRODUCTIVE EFFICIENCY IN DAIRY COWS DURING HOT WEATHER.

Product Number: 448. Funds: Hatch and State. Personnel: G. H. Stott.

This experiment was designed to find whether low-fiber, high-energy rations are practical in improving productive and reproductive efficiency in dairy cows during hot weather.

Forty-three cows, each paired with a control, were conducted through a summer and fall lactation to determine accumulative effects. The control animals were fed unlimited alfalfa hay and grained according to production. The low fiber group received 1 1/2 pounds of alfalfa hay per 100 pounds of body weight and concentrate at a level which made their energy and protein intake equivalent to those of the control group.

The animals on the low-fiber rations, though having a lower butterfat test during the hottest weather (average .17% lower test), produced more than 4% fat corrected milk (2 lbs. per-cow per-day), a higher percent solids-non-fat (0.06%), more total solids-non-fat (0.35 lbs. per-cow per-day), and more total solids (0.39 lbs. per-cow per-day), than did the cows on the control rations. But the first week in October, corresponding to cooler weather, the low fiber fed group also surpassed the control animals in percent butterfat. All the differences in production were consistent and highly significant.

No significant difference was observed in reproductive efficiency as measured by rate of involution, first service non-returns, number of services till settled, number of days post-partum till settled, embryonic death rate, irregular heat periods and general irregularities as determined by observation and periodic rectal palpation. However, 15 of the control animals were culled on the basis of low productive and reproductive efficiency by the sixth month of lactation compared to 5 cows in the treated group.. Of great economic importance, this difference is attributed mainly to the more persistent production in cows fed the low fiber rations.

5. THE RELATION OF HIGH ENVIRONMENTAL TEMPERATURE TO REPRODUCTIVE PERFORMANCE.

Project Number: 449. Funds: Hatch and State. Personnel: G. H. Stott and R. J. Williams.

Month Bred	Number Bred	Conception %	Conceived and Maintained embryos to 35 days - %	% Bred that calved
May	26	80.0	76.2	58.0
June	86	66.3	54.0	34.0
July	97	60.8	45.8	26.2
Aug.	111	58.6	29.2	16.1
Sept.	148	53.4	58.2	29.3
Oct.	171	67.8	62.6	39.9
Nov.	128	66.4	74.1	46.3
Dec.	62	87.1	55.6	45.6

Reproductive anomalies have been studied in dairy cattle in Arizona during the summer months to help resolve the problem of low reproductive performance. A high rate of embryonic death before 35 days of pregnancy was a major factor during hot weather (Table). The conception rate also decreased as the hotter weather ensued. This was partially due to lack of ovulation. Some 20% of 120 cows observed at 12-hour intervals after symptoms of heat did not ovulate. There seemed to be no significant difference in conception rate in embryonic deaths to cows that ovulated 12 and 24 hours, between 24 and 36 hours, and between 36 and 48 hours. Following the non-ovulatory estrus, irregular estrous cycles were common and generally terminated in enlarged cystic ovaries.

6. THE INFLUENCE OF OXYTOCIN ON THE INITIATION OF LACTATION OF PREPARTUM MILKED COWS.

Project Number: 450. Funds: Hatch and State. Personnel: R. G. Fossland and V. R. Smith.

As cows freshened in the herd, they were assigned to three groups - by breed - (1) no prepartum milking, (2) milking beginning an estimated two weeks prepartum, and (3) same as 2 with 2 cc of oxytocin prior to milking. There was considerable range (0.5-28.71) in amount of milk obtained on the last prepartum day. There was also considerable variation in the post partum day - on which peak production was reached. No differences attributable to breed, age of cow, or treatment were observed. Average days to reach peak production were 20, 18.5, 20 respectively for the treatments. Some evidence is adduced that the irritation and excitement caused by the oxytocin injection may have cancelled any beneficial results. This type of treatment, or for that matter the prepartum milking, is not practical in a parlor-type milking barn.

7. EXPERIMENTAL MODIFICATION OF SPERMATCGENESIS IN YOUNG BULLS.

Project Number: 465 (W-49). Funds: Hatch, Regional Research, and State. Personnel: R. G. Fossland and V. R. Smith.

Prepubertal bull calves, 15-20 weeks of age, are being assembled and will be orchectomized unilaterally, following which they will be treated with growth hormone, F.S.H. L.H. Progesterone, Testosterone, and Estradiol benzoate for periods of 2-4 weeks, after which the second testis will be removed. Histological studies will be made to observe effect if any on onset and maintenance of spermatogenesis. Preliminary studies using thyroprotein and diethylstilbesterol on pubertal age bulls were inconclusive.

8. THE CONSUMER ACCEPTANCE OF MILK BEVERAGES AS AFFECTED BY FAT AND SOLIDS-NOT-FAT CONTENT.

Project Number: 483. Funds: State and American Dairy Association. Personnel: J. W. Stull and J. S. Hillman.

Preference observations were extended to include evaluation by 125 household units. Beverages of varying composition within each class - whole, low-fat, and non-fat - were used as in the earlier ccmparisons. The results obtained confirmed the observations from respondents in food markets and public schools; i.e.,beverages with 1.9% added solids-not-fat have significantly greater consumer acceptance. The difference in preference was more marked in this trial as compared to the earlier ones.

9. VARIATIONS IN THE COMPOSITION OF MILK PRODUCED IN A HOT, ARID CLIMATE.

Project Number: 491. Funds: Hatch and State. Personnel: J. W. Stull.

Milk produced by the University dairy herd of approximately 90 animals (Guernsey, Holstein, and Jersey) is being analyzed each month for butterfat, total solids, protein, freezing point and fatty acid content. Included in the study is the analysis of milk produced by 24 Holstein animals on experimental rations of varying roughage levels, types and amount of fat in the concentrate mixture. The first of two replications on this study will be concluded on March 31, 1960. The overall study is to run for a minimum of three years. The data at this time, therefore, are inconclusive.

10. EFFECT OF ENVIRONMENTAL TEMPEPATURE AND LEVELS OF DIETARY ROUGHAGE AND FAT UPON RUMEN, BLOOD AND MILK COMPOSITION, AND PHYSIOLCGICAL STRESS.

Project Number: 501. Funds: Hatch and State. Personnel: W. H. Brown, J. W. Stull, G. H. Stott.

In recent years much work has been conducted on the effect of various concentrate-roughage ratios upon the production of milk fat, the effect of temperature upon the production of milk and milk fat, and the effect of dietary fat upon milk production and milk constituents. To date, no single study has combined these three variables. It appears from a review of the literature, however, that these effects are somewhat antagonistic to one another. It is desirable to study these factors to obtain information of a practical nature (an economical ration which could counteract to some degree the adverse effect of high temperatures), and also to obtain basic information on factors which control the formation and secretion of the milk constituents.

Twenty-four cows have been placed on experimental diets designed to study the effect of added fat and the level of roughage on milk production as affected by winter weather conditions in southern Arizona. Two levels of roughage (1 lb./100 lbs. of body weight and 2.5 lb./100 lbs. body weight) and three types of concentrate (no added fat, 6% added tallow, and 6% added cotton seed oil) are being fed. A double reversal trial is being used with five-week experimental periods. At the conclusion of each period rumen fluid samples (for volatile fatty acid analysis), blood samples (for blood fat and glucose), and milk samples (for milk fat, protein and lactose) are taken.

As the experiment is still underway results are not available at this writing.

11. THE RELATION OF FEEDING BACITRACIN TO SURVIVAL OF YOUNG DAIRY CALVES.

Funds: Commercial Solvents Corporation. Personnel: R. E. Reed and V. R. Smith.

Alternate calves born into The University of Arizona dairy herd regardless of breed and sex have served as experimental and control animals. After the calf was removed from the dam, milk was fed from an open pail at the rate of 1# per 10# body weight. Those calves designated as experimental receive 35 mg. of bacitracin dissolved in the milk at each feeding for the first three weeks of life. Calves were weighed within 10 hours of birth and at weekly intervals. A detailed clinical record was made of the condition of the calf for the first three weeks of life. At present, 20 calves have served as control and 20 as experimental. There has been no appreciable difference between the groups with respect to health and gain in weight.

12. THE RELATIONSHIP OF PHYSIOLOGICAL AGE TO INTESTINAL PERMEABILITY.

Funds: National Institutes of Health. Personnel: R. E. Reed, T. R. Varnell, V. R. Smith.

Newborn calves deprived of colostrum were treated with growth hormone to ascertain the effect of the hormone on intestinal permeability. Calves were fed colostrum at 15 hours of age. Electrophoretic analysis was made to determine whether or not gamma globulin was absorbed. The growth hormone appeared not to have an inhibitory effect on intestinal permeability. Calves have been delivered by caesarian at approximately eight months of age. Calves thus delivered were fed colostrum shortly after birth to ascertain whether or not gamma globulin could be absorbed at this time. The results were positive. Other calves delivered by caesarian and deprived of colostrum until 40 hours of age failed to absorb gamma globulin.

Department of
ENTOMOLOGY

1. INSECTS AND MITES AFFECTING ALFALFA IN ARIZONA.

Project Number: 322. Funds: Hatch and State. Personnel: D. M. Tuttle, D. Muse.

The effect of four insecticidal sprays on injurious and beneficial insects was observed on seed alfalfa. A single application was applied in the green bud stage. A toxaphene plus DDT combination was slightly more effective against the injurious insects and was also most devastating to the beneficial population. Sevin was more effective in reducing leafhoppers and three-cornered alfalfa hoppers. Dylox was particularly effective against lygus bugs and Shell 5539 for the pea aphid. Orius and Nabis survived the insecticide treatments more so than other beneficial insects present, which agrees with past observations in other tests. Sevin and Dylox are promising new materials for forage crops.

2. THE BIOLOGY AND CONTROL OF INSECTS AFFECTING COTTON IN ARIZONA.

Project Number: 383. Funds: Hatch, State, and Grant-in-aid. Personnel: G. P. Wene, D. M. Tuttle and L. W. Sheets. (In cooperation with U.S.D.A.)

Severe beet armyworm infestations were controlled with the following sprays: 1.5 pounds of Dylox per acre: 0.5 pound Dibrom with 0.3 pound of endrin. Ordinarily, the beet armyworm lays its eggs on the ventral surface of cotton leaves but in the Hidden Valley and Rainbow Valley the infestation was so severe that egg masses were found on the dorsal surface of the cotton leaves.

Effectiveness of sprays and dusts applied by airplane was compared. The data show that both methods of application can be used to obtain commercial control of Arizona cotton insects, although spray applications are slightly more effective than dust applications in controlling beet armyworms and cotton leaf perforators. Spider mite populations built up faster during spray applications than during dust applications. This may be due to the sulfur which is usually incorporated in dust formulations, as a spider mite suppressant.

The importance of early season control of lygus bugs and other square destroying insects was demonstrated by the "square removal" experiment. In this experiment, small squares were picked off the plant till June 15, July 1, July 15, and August 1. A delay of cotton squaring until August 1 (by picking off small squares to simulate lygus bug injury) reduced the November 11 harvest approximately 50% when compared to the plots that had the squares removed only until July 1. Delayed square setting (caused in this case by picking off the squares) also resulted in approximately 650 pounds decrease in the amount of seed cotton harvested. This experiment showed the importance of lygus bug control during the month of July, which not only increased yields but matured the cotton crop earlier.

Lygus bugs were effectively controlled with the following insecticides: Strobane, Trithion, Dibrom, Dimethoate, Diazinon, Dilan, Korlan and Shell 4402. A large scale field test showed that 20% Toxaphene dust with 40% sulfur also gave effective control of lygus bugs.

Data taken in 1959 show that the proper choice of insecticides for the control of lygus bugs and bollworms will automatically control cotton leaf perforators. Malathion was applied to half of a check plot which had a heavy cotton leaf perforator population and noticeable injury. This late application of malathion did not increase the amount of cotton harvested and again showed the importance of controlling the cotton leaf perforator before the population had built up to destructive numbers.

Bacillus thuringiensis Berliner, was very effective in controlling the salt-marsh caterpillar. This material, having a spore count of one billion bacteria per gram, was applied as dust at 50 pounds per acre. Another dust formulation, containing three billion spores per gram was applied at 30 pounds per acre and was also effective. Dilan applied at 0.7 pound per acre killed larvae as they emerged from egg masses for a period of 13 days. Increasing the rate of Dilan to 1.0 pound per acre did not increase its residual effectiveness. The addition of Toxaphene-DDT to Dilan increased the effectiveness of the latter against half-grown or larger salt-marsh caterpillars.

A dust containing 15% toxaphene plus 5% DDT with 40% sulfur was applied at various time intervals throughout the season. Applications at 14-day intervals resulted in a severe bollworm infestation which reduced yields of seed cotton as compared with untreated plots. Best control of all cotton insects was obtained with the Toxaphene-DDT dust applied at a 10-day schedule starting at July 1 and continuing through August. If a limited number of applications is to be made, these(four in number) should be applied during August.

Dibrom, an organic phosphate insecticide, is effective against the cotton bollworm. However, it has a short residual life and DDT should be added to increase its effectiveness. Diazinon and Dimethoate, when used repeatedly without DDT, also built up destructive bollworm populations.

Data again showed that spider mites on cotton had developed a resistance to organic phosphate insecticides. Kelthane, aramite and Tedion gave effective control. Kelthane, as spray, is more effective when applied by ground equipment than by air. It was interesting to note that 7.5% Sevin dust built up a spider mite infestation faster than a 10% DDT dust. During June, Orius nymphs and adults fed on spider mites and actually controlled the spider mites in one field.

Pink bollworm adults emerged from March 19 through July 13. The bulk of the emergence occurred before any cotton squares were observed in the field on May 26. Burying infested bolls to a depth of 6 inches did not prevent adult emergence.

Data taken at Safford show that eight DDT dusts applied at 6-day intervals practically eliminated pink bollworms in fields which had been heavily infested during 1958.

3. THE BIOLOGY AND FOOD PREFERENCES OF THE KHAPRA BEETLE AS THEY RELATE TO GRAIN MARKETABILITY.

Project Number: 389 (WM-16). Funds: Regional Research and State. Personnel: W. L. Nutting, Anthony Ross, L. A. Carruth. (In cooperation with the Departments of Entomology, U.S.D.A., and Agr. Marketing Service, Biol. Sciences Branch.)

1958 work represented largely a continuation of the controlled bin studies begun in 1956 in which khapra beetle larvae were introduced into experimental bins to compare development in two kinds of grain, of two grades, each maintained at two moisture levels. 1958 observations support preliminary observations, previously reported, that the khapra beetle shows relatively little or no developmental activity below 25 degrees, centigrade, but that infestations become active, particularly near the grain surface, above this temperature level.

A latent period, varying from 14 months to a much longer period, appears to exist between an initial infestation and the time when a population may be considered heavy by visual examination.

During 1958 tendencies toward quiescence, or diapause, were observed which appear to be associated with high larval populations, deteriorating food supplies and changes in temperature. This phenomenon is now under further study.

The work of this project will contribute greatly to knowledge needed for the intelligent handling of grain and grain products, and toward the reduction of direct and indirect losses in the event that the khapra beetle becomes established in the United States. This research, under quarantined conditions, is valuable insurance for other areas of the United States where large quantities of grain and grain products are maintained in storage.

4. INSECT PARASITES AND PREDATORS AFFECTING INSECT PESTS OF ARIZONA CROPS.

Project Number: 404. Funds: Hatch and State. Personnel: G. D. Butler, Jr.

The first phase of this project, emphasizing the identity, distribution and abundance of parasitic and predaceous insects of importance in Arizona crop areas continued to be the area of greatest emphasis, particularly the hymenopterous parasites. The Ichneumonids in the University collection were sorted further but work was handicapped in several of the most important groups by the lack of a specialist in these groups and the need for revisions of the groups. The collection of Braconidae, except for three subfamilies, was identified by C.F.W. Muesebeck, Washington, D. C. From this collection a report was prepared on the identification of the more abundant Braconidae of Arizona crop areas, their distribution in Arizona and a summary of the literature of their life history and hosts. The 5,000 Chalcidoidea collected in crop areas were sorted further but the work was handicapped by the lack of identified material. A sample of 100 specimens was sent to Washington for identification.

A number of abundant and important parasites of injurious economic insects have been found and are candidates for future biology and population studies.

5. INSECTICIDE RESIDUES: THEIR NATURE AND PERSISTENCE ON ARIZONA CROPS.

Project Number: 416 (W-45). Funds: Hatch and State. Personnel: J. M. Witt, Project Leader; G. F. Bagatella, Research Associate.

The insecticide residue program to determine dissipation curves under the Arizona conditions of high temperature and low rainfall was continued. The following plots are part of the residue analysis program:

Crop	Insecticide	Rate	No. Applic.
Lettuce	DDT	2.6 lbs/A	IX
		5.2 lbs/A	IX
	Endrin	0.5 lbs/A	IX
		0.5 lbs/A	4X
	Sevin	1.0 lbs/A	IX
		2.0 lbs/A	IX
	Toxaphene	3.0 lbs/A	IX
Alfalfa	Parathion	1.5 lbs/A	IX
		1.5 lbs/A	2X
	Sevin	2.0 lbs/A	IX

As part of the residue program, the variance of various sampling, subsampling, and extraction procedures were studied. Purification procedures were quantitatively compared as part of the contribution to the Sub-committee on "Pesticide Purification Methods in Pesticide Residue Analysis," W-45 Regional Technical Committee. During work in 1958, it was noted that field application of insecticides on small plots was often subjected to unnecessary error due to inadequate equipment. This was partially corrected in 1959 through the development, with Dr. Paul D. Gerhardt, of a more precise, low capacity, spray rig.

The dissipation curves of these insecticides will provide a basis for assuring that the chemical insect control recommendations for Arizona are made in compliance with the Miller Amendment.

6. THE BIOLOGY AND CONTROL OF ARIZONA VEGETABLE INSECTS.

Project Number: 418. Funds: State. Personnel: Paul D. Gerhardt, Don L. Turley.

Applications of granular thimet-fertilizer mix applied to potatoes at planting time gave satisfactory control of aphids during most of the growing season.

Sprays of endrin at 1/2 lb. actual per acre were applied to lettuce at weekly intervals beginning at thinning time. The number of applications ranged from 2 to 5. Good control of loopers, beet armyworms, and several other lepidopterous larvae were obtained with the endrin treatments. Chemical analysis of the lettuce for endrin residues is being conducted in cooperation with the Shell Chemical Company.

Several other new insecticides were applied to lettuce for lepidopterous larvae control. One of particular interest was an antifeeding compound which was also effective on cole crops against loopers.

Bacillus thuringiensis Berl. was also used on lettuce with promising results.

Granular insecticides applied to the soil at planting time can give protection as long as 6 to 8 weeks against aphids, psyllids and leaf hoppers. This could eliminate 2 to 3 insecticide applications in the early part of the growing season. If endrin residues are not found in lettuce treated after thinning, it may be possible to obtain registration for use of this insecticide closer to harvest than now permitted. The antifeeding compound could prove very useful in preventing the feeding of chewing type insects. The Bacillus may have an important place in insect control on crops where insecticide residues are a problem close to harvest.

7. ARIZONA INSECTS OF ECONOMIC IMPORTANCE.

Project Number: 419. Funds: State and Research Contract. Personnel: L. A. Carruth, P. D. Gerhardt, D. M. Tuttle and other Staff Members.

Aerial applications of 3% Diazinon, 2% Malathion and 2% BHC, controlled corn leaf aphids on barley, although no appreciable increase in yield could be attributed to the treatments. 3% Diazinon dust gave good control of English grain aphids on wheat.

Populations of citrus thrips were heavier than usual during 1959 especially on tangerines and Kinnow Mandrin. Treatments with Dieldrin, Dibrom, Dibrom-Dieldrin, Diazinon, Tartar Emetic and Sabadilla were compared in several groves. High thrips populations were not controlled with single treatments. Two treatments were adequate in most cases to prevent fruit damage. Fall treatments were necessary for young trees to prevent damage to the new growth. Dieldrin and Diazinon gave equal control with little difference when Dibrom was added. Tartar Emetic did not give the quick knockdown Dibrom did, but continued to give Citrus thrips control over a longer period of time.

In tests for the control of thrips on bermuda grass seed crops a mixture of 0.016 percent pyrethrins in a specially formulated diatomaceous earth diluent was not effective in 1959. Formulations containing parathion or diazinon effectively reduced thrips injury and controlled other insect pests associated with bermuda grass seed crops.

Studies were continued on the identification and hosts of plant feeding and precaceous mites. A preliminary list of species was published. In preparation for further work, D. M. Tuttle attended the National Institute of Acarology at College Park, Maryland, in the summer of 1959.

Among other studies begun under this exploratory project in 1959 were the control of flies in dairy establishments, the nature and control of mites, scales and other pests of lawns and the nature of the insects present in a commercial pine forest in northern Arizona. Preliminary studies were made of insects affecting the production of range grass seed crops. These studies are continuing and will be reported in detail in future reports.

More practical and effective control recommendations for pests of barley, citrus and bermuda grass crops have been developed. New information on plant feeding mites has already disclosed several new species and records from Arizona. This project formalizes miscellaneous essential activities not covered in other projects, some of which have already been developed into new projects.

8. INSECT PARASITES IN RELATION TO REDUCING CHALCID INJURY TO ALFALFA SEED CROPS.

Project Number: 445 (W-43). Funds: Regional Research and State. Personnel: G. D. Butler, Jr.

A re-examination was made of unpublished observations on the clover seed chalcid and its parasites from an experiment conducted from 1952 to 1954 at Yuma, Arizona. There was no major effect of either spacings of the alfalfa plants or of moisture treatments on clover seed chalcid or parasite abundance. There was a high correlation between the number of racemes and pods collected in samples and the number of clover seed chalcids that emerged. The number of clover seed chalcid

parasites was highly correlated with the clover seed chalcid populations in all treatments. It is concluded that the clover seed chalcids responded to the ecological conditions which modified the number of racemes and pods present on the plants. In a similar manner, the parasites responded to the number of chalcid hosts available.

Identifications were made of the chalcid parasites collected from 190 alfalfa fields in Arizona, California, Idaho, Utah, and Washington. Liodontomerus perplexus was by far the most abundant species in all areas of the seven parasitic species collected. Trimeromicrus maculatus was quite abundant in Washington, California, and parts of Arizona. Samples showed that there was activity of the clover seed chalcids and parasites in Yuma throughout the winter.

Two of the three species of clover seed chalcid parasites most abundant in Arizona are important in other Western States. Therefore, basic studies on the factors affecting the abundance of the parasites in Arizona will be of importance to the whole Western Region.

9. PHYSIOLOGICAL STUDIES OF ARIZONA INSECTS.

Project Number: 461. Funds: State and Research Grant. Personnel: W. L. Nutting, J. M. Witt, and L. B. Koenig.

Laboratory equipment and facilities are being assembled for intensive studies of the endocrine system in controlling the development of heminetabolous insects. Work has been handicapped by inadequate time and facilities. Studies were begun on possible endocrine factors involved in caste determination, flight and seasonal dissemination of winged termites. This work in its first stages has been limited to the study of flight patterns of local termite species in relation to meteorological conditions, rainfall and time of day. This work is continuing.

Work on the studies of detoxication mechanisms has continued, focussed primarily on attempting to determine the metabolites of C-14, labeled chlorobenzene after injection into the American cockroach, horse lubber grasshopper, and the salt-marsh caterpillar. One metabolite, P-chlorophehylmercapturate, has been tentatively identified by chromatographic comparison with the same metabolite produced by the white mouse. A detailed report of this work has been made in a 1959 report to the Herman Frasch Foundation.

The work with termites should provide new scientific information which conceivably could lead to the prediction of the time of termite flights and more effective termite control programs in urban areas. The detoxication studies may ultimately lead to improved insecticides.

10. TAXONOMY OF ARIZONA ECONOMIC INSECTS.

Project Number: 466. Funds: State. Personnel: F. G. Werner, (M. S. Adachi - Jan.-Aug., K. S. Radford - Sept.-Dec.).

Manuscripts were completed during the year on the following insect groups in crop areas: Pests-Diabrotica and related genera, flea beetles (Coleoptera; Chrysomelidae), Pentatomidae (Hemiptera), Blapstinus and related genera Coleoptera; Tenebrionidae), Predators-Coccinellidae (Coleoptera), Collops (Coleoptera; Malachiidae), Parasites-Braconidae (Hymenoptera, the more abundant genera). Work on a report on the Miridae is substantially complete but publication is being delayed while the identity of Lygus desertus is being worked out.

All of the groups covered include species of importance to agriculture, as pests, parasites, or predators. Proper identification should be more possible by the use of the findings reported.

11. DEVELOPMENT OF REFERENCE COLLECTION OF ARIZONA INSECTS.

Project Number: 467. Funds: State. Personnel: F. G. Werner, (M. S. Adachi-Jan.-Aug., K. S. Radford - Sept.-Dec.).

Dr. W. T. M. Forbes, Professor Emeritus of Entomology, Cornell University, worked with the collection of Lepidoptera from January to May. Dr. Forbes is one of the top taxonomists in this order and his many identifications have given us a good start on a reference collection of moths. More than 12 drawers of Lepidoptera were added to the collection during the summer. All of the major orders are now represented in the adult collection by at least a nucleus of identified Arizona specimens.

Miss Adachi made significant contributions to the collection of Diptera while she was here, by adding specimens, sorting to family and identifying some groups to species. Most of the families for which a specialist is available now are represented by identified specimens.

The "Biology of Insects" contract with A.R.S., U.S.D.A. continues to add identified specimens of immature stages of insects to the alcoholic collection. This collection is currently being sorted, labeled and put into safe storage in jars. The job is about half completed.

An inventory of the adult collection was made during October. As of that month it occupied 759 drawers, and contained 180,260 specimens, including 8,859 identified species, of which 5,606 belong to the Arizona fauna. Species not yet identified would probably add several thousand Arizona species.

During late August and early September short collecting trips were made to five areas in Sonora and the length of Baja California. These trips yielded large samples of insects. The samples have not yet been mounted and labeled but will give us a much better idea of the relationship of the Arizona insect fauna to that of northwestern Mexico than we have now.

Our knowledge of the Lepidoptera and Diptera of Arizona has increased considerably during the year and accurate identification of insects in these orders is possible in many cases.

School of
HOME ECONOMICS

1. THE EFFECT OF WARM CLIMATE ON BASAL METABOLISM AND BLOOD SATURATION LEVELS OF ASCORBIC ACID.

Project Number: 370. Funds: Hatch and State. Personnel: Ethel M. Thompson and Mary Ann Kight.

A study was made of the relationship of a diminishing level of ascorbic acid to the concentration of total cholesterol in the serum of young women 27 to 30 years of age. Two of the subjects were studied for three thirty-day periods and one for two thirty-day periods. Two were maintained on a diet low in ascorbic acid but otherwise adequate throughout but received a 400 mgC supplement daily during the first period for saturation and 0.4 mgC/kg body weight during the following period for depletion. One continued for a third period with no supplement. A third subject received an ad libitum diet throughout with 400 mgC during the first period and no supplement during the second and third periods.

No statistically significant differences in total cholesterol concentration were observed between the experimental periods of any of the subjects except for the subject who continued for the third period on the basal diet with no C supplement. Results obtained with this subject indicate the desirability of continuing this study with more subjects.

Milligrams of total cholesterol per 100 ml serum with diminishing concentration of serum total ascorbic acid for the three subjects are shown below:

I. (60-66 days)

	Saturation Period			Depletion Period		
Subject	Diet	MgC[1]	Cholesterol	Diet	MgC	Cholesterol
MK	Basal[2]	400	257[3]+ 16.94, -6.39%	Basal	0.4/kg	256+21.31, -8.45%
MM	Basal	400	197 + 9.57, -4.86%	Basal	0.4/kg	195+11.82, -6.07%
NV	Ad libitum	400	247 + 13.31, -5.39%	Ad libitum	none	247+16.96, -6.86%

II. (41-43 days)

	Saturation (10 days)		Depletion Period		
Diet	MgC	Cholesterol	Diet	MgC	Cholesterol
Basal	400	254	Basal	None	239+11.74, -4.92%
--	--	--	--	--	--
Ad libitum	400	241	Ad libitum	None	244+17.83, -7.31%

1 Daily ascorbic acid supplement. 2. Basal diet, repeated daily, contained by analysis 24.24 mg ascorbic acid, 53.53 mg total ascorbic acid.
3 Standard deviation of the mean and coeffieicnt of variation.

Study of further subjects will be made as a separate project and Hatch 370 will be closed.

Thompson, E. M., Staley, M. G., Kight, M. A. and Mayfield, M. E., The Effect of High Environmental Temperature on Basal Metabolism and Serum Ascorbic Acid Concentration of Women, J. Nutr. Vol. 68, 1959, pp. 35-47. (Publication)

2. THE RELATION OF WARM CLIMATE TO BASAL METABOLISM AND BLOOD CHOLESTEROL.

Project Number: 420 (W-44). Funds: Regional Research and State. Personnel: Ethel M. Thompson and Mary Ann Kight.

Progress of study of twelve men as subjects.

Mailmen, 25 to 46 years of age who walk on their delivery route, have been subjects since May, 1959. Monthly average maximum temperatures to which they have been exposed to date are: 89, 100, 99, 92, 94, 84, 71, 63 and 59°, respectively. Dietary surveys, following the procedures of Burke and of Young, have been completed for the winter season. Blood has been analyzed monthly for hemoglobin (Alkaline-Hematin) since December, 1959. Basal metabolism determinations, including blood pressure, have been made during the winter months. Using the same procedures as reported previously for women subjects, weekly serum analyses for total cholesterol have been completed through September, 1959. Average weekly total cholesterol concentrations for 2 cases are<200 mg%, 4 between 200-250 mg%, and 6, 250-300 mg%. Since that date serum samples have been frozen for future analysis.

Average monthly protein-bound iodine values for the group beginning September, 1959, are 3.9, 3.9, 4.9, 5.2 and 6.3 mcgm%. The number of cases classified on the basis of monthly values as being subnormal beginning in September through January are 3, 5, 1, 0, and 0; low normal, 7, 2, 2, 2, and 0; normal, 2, 5, 7, 9 and 2; and high normal, 0, 0, 2, 1 and 7. Control serum, reported by Hyland Laboratories to be 4.9 (4.7-5.1) mcgm%, and analyzed by the same method (Barker, dry ash, modified) in this laboratory concurrently with the sera of subjects, averaged 4.8 (4.4-5.4) mcgm%.

3. INTERIOR AND EXTERIOR TREATMENTS TO MODIFY BRIGHTNESS OF NATURAL LIGHT TO THE LEVEL OF HUMAN COMFORT.

Project Number: 482 (W-69). Funds: Regional Research and State.

The exterior aspect of this project is being studied at the present time. The main purpose of this work is to find ways of making a comfortable visual environment in the Southwest. It is assumed that this objective may be accomplished by determining how much lightness the human eye accepts as being comfortable, identifying causes of excessive lightness, eliminating those causes. Since color is a component of all buildings and their surroundings, hence a factor in all aspects of the study, the first experimental work will evolve around response of human subjects to the three attributes of color. Pilot studies will be conducted to find out if subjects will respond to lightness, the physical characteristic of color, independently of the color characteristics of hue and saturation. Equipment and procedures have been prepared to determine the influence of the three attributes of color on heat absorption. Twenty-four color panels will be included in the first test group. This sampling is sufficient to measure the influence of hue on heat absorption and to determine the selection of color panels needed to extend the testing to obtain comparable information regarding saturation and lightness.

The test will be a comparison of temperature rises between the color panels and standard black panels. This work will be done in cooperation with the Solar Energy Laboratory.

While the scope of this project at the present time is confined to buildings and their surroundings, it offers possibilities for being extended to farm machinery and motor vehicles.

4. ROLE MODIFICATION AND PARTICIPATION IN FAMILIES OF HANDICAPPED HOMEMAKERS.

Project Number: 479. Funds: State. Personnel: Victor A. Christopherson and Isabelle Dewey.

The project was limited to a study of the role modifications of the handicapped mother. Other family members will be included in subsequent studies.

The passage of the Independent Living Rehabilitation Bill S.772 will permit many of the more than ten million disabled homemakers to qualify for vocational and other forms of rehabilitation. The data indicated that homemaking adequacy and role adjustment tend to be independent of the severity of the handicap. Both personal competency and environmental modifications helped maximize role adequacy. The maternal roles concerning child care were the most difficult of the homemaking roles in which the handicapped mother attempted to achieve a sense of adequacy. The subjects were inclined to utilize standard rather than special equipment whenever possible. In part, this seemed related to the desire to form identifications with the normal mother. Children of handicapped mothers tend to learn self-care skills somewhat earlier than children of normal mothers. Community activities appear to constitute an important source of rehabilitative activity as indicated in the net gain of 4 percent with respect to the community participation after the disability. Two of the principal approaches to the rehabilitation of the handicapped homemaker are: first, training in work-simplification, or how to accomplish household tasks in the most economical way; second, to sensitize the disabled homemaker to the possibilities of the "enabling role." Perception proved to be a major factor in the role adjustment of the handicapped homemaker.

The study was based upon interviews with 120 orthopedically handicapped mothers with children under 12 years of age. Eighty-four subjects constituted the final sample.

The findings should prove useful to those concerned with the general rehabilitation of the physically handicapped, and in particular to those who work with handicapped homemakers - home economists, nurses, and agencies concerned with the problems of the orthopedically handicapped. The findings on role modifications and adjustments should also be of interest to sociologists and some psychologists.

"Role Modifications Of The Handicapped Homemaker," Rehabilitation Literature, April, 1960 (lead article). (Publication)

5. COLLEGE MARRIAGE IN PUBLIC AND PRIVATE INSTITUTIONS OF HIGHER EDUCATION.

Project Number: 480. Funds: State. Personnel: Victor A. Christopherson, Joseph S. Vandiver and Marie Krueger. (In cooperation with Dept. of Sociology and Rural Life, Oklahoma State University, Stillwater, Oklahoma.)

With regard to the assumption of household tasks by the husbands of the subjects, the student group did not differ appreciably from the control group. The level of living, as measured by money income and ownership of household furnishings, was not as high among student families as among control families. The anticipated income among student families, contrary to expectation, was also lower than among non-student families. The same percent of student families owned cars as did control group families. A greater percent of student families owned television and hi-fidelity radio sets. The anticipated family size of the student families was greater than the size of the families in which they were reared, and also greater than the anticipated size of the control group families. The majority of the student couples preferred to wait until after the husband's graduation to begin or add to their families. The reasons were principally economic in nature. Student partners assumed full responsibility for child care in a greater number of cases than was expected. Reciprocal baby sitting arrangements among student parents were not pronounced. Thirty-seven percent of the student families were financially subsidized by the parents and 27 percent received help in the form of furnished or loaned household items. There were more favorable than unfavorable responses by student couples toward college marriage.

College marriage has become apparently independent of veteran enrollment, and includes from one-fifth to one-fourth of the students on many--perhaps the majority of the nations college campuses. Housing for undergraduates is more common than the practice of restricting housing to graduates. The general trend is for institutions to add to the number of housing units for married students, particularly when there are currently more than 300 such units already constructed. State institutions have a good deal more housing for married students than private institutions by count and in relation to the number of married students enrolled. The more expensive student housing units tend to be either furnished or of a permanent construction type. The trend appears to be away from the "veteran village" temporary, barracks-type unit, and toward the especially designed, permanent-type unit. College students are marrying at an earlier age than their parents, and they are having more children and also, are spacing them closer together. As of 1958 the majority of colleges and universities studied reflected a favorable or neutral attitude toward college marriage.

The data and findings of this study should provide home economists and social scientists with more complete and recent material for their classes than has been available. Information based on the study has been requested by college administrative officers, social scientists, and by the Reader's Digest.

"College Marriage In Public and Private Institutions of Higher Education 1943-1958," Family Life Coordinator, March, 1960. (Publication)

"The Married College Student, 1959," Marriage and Family Living, May, 1960. (With Dr. J. S. Vandiver, Oklahoma State University). (Publication)

Department of
HORTICULTURE

1. BREEDING AND IMPROVEMENT OF MELON VARIETIES.

Project Number: 295. Funds: Hatch and State. Personnel: R. E. Foster, E. L. Murdock, H. Dennis.

In addition to selecting for crown blight resistance in muskmelons, considerable attention has been paid to the maintenance of quality in all stocks. Success in this portion of the program was indicated in the variety trials placed in four different locations in Arizona. Along with ten other strains, a U.of A. strain was compared for all items of quality. In most categories, the new strain surpassed all commercial types. Commercial strains 450-A and Sierra Gold performed well; details available in special report. In breeding program, 793 progeny were obtained from successful hand pollinations in the spring and 1,262 in the fall at both Mesa and Yuma. Program includes cantaloup, honey dew, and casaba. These are progeny with moderate-to-good crown blight resistance, single-plant selected or crossed with high-quality types. Many of the selections are also moderately or highly resistant to powdery mildew as revealed in extensive assays furnished gratis by Dr. G. W. Bohn, USDA, La Jolla. Crown blight resistance appears to be correlated in part with reaction to virus incidence in field. Tests for possible virus resistance in selected muskmelons being continued in Mesa greenhouse. Some families give indication of resisting watermelon mosaic infection (mech. inoc.). As aid to hybrid seed program, gametocide tried in various concentrations in field test. Some male sterility noticed, but herbicidal effect pronounced and results to date inconclusive.

Until crown blight resistance strain perfected, new strain mentioned above considered for interim release as improvement for Arizona industry in production of high quality crop. Progress is being made in combining crown blight resistance with high yield and high quality types. Mosaic resistance will improve strains greatly even if crown blight not controlled. Hybrid seed with attending advantages badly needed. The gametocide studies may provide an economic method of producing hybrid seed.

2. MELON PHYSIOLOGY - FACTORS AFFECTING THE QUALITY OF ARIZONA MELONS.

Project Number: 296. Funds: Hatch and State. Personnel: W. D. Pew, G. C. Sharples, James H. Park.

An evaluation of the data obtained from this test during the past three years has shown a remarkable uniformity from year to year. Study of the root systems indicates that irrigation procedure, including the amounts of water used, is instrumental in determining the type of root development that can be expected. Variation in the water stresses, prior to watering cantaloup plants, indicates that plants receiving a high level of water during early growth are far less adaptable to subsequent changes in water levels than are plants grown under stress conditions early in the season. An examination of the root systems of plants having received very high levels of moisture early in the growth period reveals a shallow, poorly extended root system which is not capable of utilizing deeper water. The data indicate that 6 irrigations were ample to produce a high production of desirable cantaloups. The use of 17 irrigations was inferior to either of the 6 or 10 irrigation treatments. Varying the water levels at definite, but different, intervals during the growing season is also very important in determining the type of root system developed. Water utilization figures indicate a

maximum of 18 acre-inches for cantaloups. The maximum utilization period occurs during the early fruit-formation period.

Cantaloup plants were grown under field conditions at widely varying soil nitrogen levels in an attempt to relate growth of plants and fruit production to leaf analysis data. Leaf nitrogen content one week before harvest was strongly related to the total amount of fruit per plant and to the yield of marketable fruit per acre. Leaves obtained at thinning time, three weeks before harvest, had about the same N content regardless of amount of nitrogen applied. The size of fruit was not affected by the nitrogen level. Phosphorus in leaves obtained at harvest time varied inversely with nitrogen level. Because the foliar response to applied nitrogen appears late in the season, leaf analysis appears to have little promise for predicting growth and production potential.

These data are valuable to the commercial grower of cantaloups from at least two points of view. First, they are important from a labor and water conservation standpoint and second, from the economic ease and facility of handling the crop in the the field which otherwise would be difficult where furrows have been maintained in a a wet condition.

Because earlier findings indicated some of the symptoms described as "crown blight" of melons were those of nitrogen deficiency, it is desirable to understand better the physiological nitrogen responses of cantaloup and see if it is possible to predict them in advance.

3. LETTUCE BREEDING IN ARIZONA.

Project Number: 297. Funds: Hatch and State. Personnel: R. E. Foster and E. L. Murdock.

Major portion of activity concerned with continuation of extensive variety testing in three important lettuce areas of state. Detailed data obtained, processed statistically and summarized in special variety report. New lettuce strain tried in nine different tests, found to be high-yielding, high quality, tip burn resistance type; announced for release (G. L. type). Further selection and restricted testing on Imp. type also tip burn resistance considered for release. Trials and selections continued for rib discoloration, pink rib, and bolting resistances. New program initiated for selection of big vein resistance - special area, Yuma station. Replicated tests, breeding plots, and seed increase areas now in progress for all of above phases. Gametocide studies continued, application rates and intervals found very important to increase male sterility and reduce herbicidal effects. 2400 to 4800 ppm at 7-to 10-day repeat applications produce complete male sterility but effect evanescent unless treatment continued. Some injury and stunting of plants occurs. Certain additives (Fe & N & Systox) of no value. Breeding for downy mildew immunity (available from U.S.D.A stocks) discontinued because of lack of greenhouse facilities.

Variety test results of considerable value to growers in all major areas. New Great Lakes strain (name "Arizona Sunbright") shows measurable resistance to one of major diseases, tip burn. Strain can be used during tip burn seasons and may extend planting and harvesting dates in tip burn areas. Perfected methods of using male gametocide may make hybrid lettuce seed production economically feasible. Resistance to other major diseases of great importance to lettuce industry.

4. LETTUCE PHYSIOLCGY - CULTURAL FACTORS AFFECTING THE PRODUCTION OF LETTUCE IN ARIZONA.

Project Number: 298. Funds: Hatch and State. Personnel: W. D. Pew and James H. Park.

Irrigation Test: This test was not conducted as planned due to unseasonably wet weather during the normal planting period and planting could not be done.

Fertilizer placement study with late spring lettuce in this project is currently in progress, hence results are not available. However, it is planned to get detailed information on root development throughout the growing season. Also, effects of fertilizer application equipment on root pruning and the influence of fertilizer concentration on root burning and development are to be determined.

Data are not available at this time to determine their usefulness; however, it is hoped that the test will provide information on the proper positioning of fertilizer and maximum utilization by lettuce plants. Also it is hoped that it will provide information concerning the influence on both mechanical and chemical interference with root development.

5. FACTORS AFFECTING THE PRODUCTION OF CITRUS IN ARIZONA.

Project Number: 299. Funds: Hatch and State. Personnel: R. H. Hilgeman, L. Burkhart, J. R. Kuykendall, G. C. Sharples, C. R. Everling.

A. SALT RIVER VALLEY

1959 Season. Temperature conditions during January, February, March, and April were well above normal, with precipitation very much below normal. Above normal diurnal variations occurred so that mean minimum temperatures were slightly below normal. There were 23 nights below 32°; no temperatures below 26° F. occurred; no frost damage occurred. Little fruit growth took place during the winter. Yellowing of leaves was moderate to serious. Moderate defoliation of grapefruit developed in February with normal leaf drop on oranges. New growth with blossom development started in mid-February was slow in early March but blossoms developed rapidly in late March so that full bloom dates were near normal. Full bloom covered the following periods: Washington Navel, March 31 to April 5; Valencia, April 3 to April 8; Grapefruit, April 5 to April 9; Algerian tangerine, April 5 to April 11. Blossoming was slightly heavier than normal. Algerian tangerine was exceptionally heavy although about 20% of the blossoms dropped before opening. Five degrees above normal temperatures of late March, April and early May were followed by below normal conditions until June 10. During the fruit set period from bloom until June 7 only 10 accumulative degree days above 100° F. occurred with a maximum temperature of 103° in May. Fruit setting was exceptionally heavy on lemons, Valencia and seedling oranges and tangerines, heavy on grapefruit and moderate on Washington Navel oranges. In late June during a 15 day period when temperatures were between 108° and 113° F. small Valencia fruit grew very slowly or failed to grow. These fruit remained small and some split in the fall. After generally very high temperatures in July (5° above normal) slightly below normal temperatures with rainfall above normal then prevailed through October. Excessive rainfall in late October, November and December, interferred with normal harvest operations. The first killing frost occurred on November 27 with a temperature of 29° F.

Quality of grapefruit was generally low. Grapefruit peel was thicker and acid higher than in any year during the past five years. Round fruit with occasional "sheep nose" types developed although the size of the fruit was smaller than normal. Granulation of Algerian tangerines, which was present in late October, became so severe that part of the crop could not be sold. The Washington Navel orange failed to develop proper color on the trees and did not color well in the maturation rooms. Some fruit on trees growing on rough lemon root developed serious granulation. Lemon quality was satisfactory.

Tree growth was generally very satisfactory considering the large crop on the trees. Leaf color was good with trees low in nitrogen during the early summer developing a good green color in the fall. Salt injury was slightly less serious than usual. Iron chlorosis was less than in previous years but zinc deficiency patterns were more prevalent.

Mesophyll collapse in grapefruit began on October 10, but spotted. More general damage occurred between November 10-15. A third period of injury which damaged the lower south side of the trees occurred in late November.

A few small infestations of cottony cushion scale started but control by the vedalia beetle immediately occurred. Thrips presented a serious problem throughout the year. High populations developed in the spring and apparently continued throughout the year. Severe damage to new growth particularly on nursery and young Navel trees occurred. Control with the usual insecticides was largely ineffective.

Varieties

733 trees of nucellar or improved varieties imported from California were grown and planted at the Citrus Branch Station and in co-operative plantings with growers. The following varieties were involved. Redblush and Marsh grapefruit; Frost Navel, Tibbets Washington Navel (original tree) Campbell Valencia and Frost Valencia oranges; Monroe and Foothill lemons; Kinnow and Willowleaf mandarin; Alspice and Orlando tangelo. In addition, the Chapman and Wood Valencia varieties were propagated to use for control comparisons. Part of the trees were grown on Rough lemon and part on sour orange rootstock. Approximately 30,000 buds were distributed from the station and through the cooperative growing program with the nurserymen.

Trees were placed with the following co-operators: Bard ranch (H. B. Powers), Walter White, Tyler-Nickolson, Fletcher groves, Virgil Merrill and Tal Wi Wi ranch.

Rootstock Trials

The third crop of fruit was harvested from trees planted in 1952 at the Yuma Mesa Citrus Experiment Station, the Citrus Branch Station and at Rancho Santa Maria in the Salt River Valley (Table 1). Larger yields with lesser tree growth have occurred with most rootstocks in the Salt River Valley than at Yuma. At the Citrus Branch Station, Rough lemon, Rangpur lime, Citrumelo and sour orange yields and tree growth have not differed significantly. At Rancho Santa Maria, the rootstocks have not significantly changed either yields or tree growth.

While the differences in yields are not statistically significant, it is noteworthy that either the Rough lemon or the Rangpur lime have produced the most fruit at each location. No definite conclusion can be drawn from this test at present.

Effect of Rootstock on Lisbon Lemon Yields and Tree Growth - Table 1

Rootstock Variety	Yield (A) (55# boxes/tree)			Trunk Area (sq. centimeters)		
	Salt River Valley		Yuma	Salt River Valley		Yuma
	Citrus Expt. Sta.	Rancho Santa Maria	Citrus Expt. Sta.	Citrus Expt. Sta.	Rancho Santa Maria	Citrus Expt. Sta.
Rough lemon	7.2	9.5	3.1	227	215	277
Rangpur lime	7.2	8.6	3.8	197	195	236
Citrumelo	6.7	7.8	2.1	179	190	168
Sour orange	5.7	-	2.2	197	-	182
Troyer cit	5.0	7.4	2.0	175	205	213
Sweet orange	4.7	7.9	1.9	170	217	197
Wilking mand.	2.7	-	-	150	-	105
LSD (B)	1.9	n.s	2.3	48		

(A) Total fruit produced since planted, yields in '56, '57, '58. 94

Effect of Tillage on Root Development - Table 2

The root development of grepefruit trees growing on sour orange root was observed under four tillage practices which had been in effect during the preceding 10 years.

Feeder Root Development under Different Tillage Programs

	Roots at Different Depths*							Area Trunk (a)
	0-6	6-12	12-18	18-24	24-30	30-36	Total	
Non-tillage (bare)	9.0	8.7	11.2	8.8	5.1	2.5	45.3	183
Bermuda mowed	17.6	10.0	12.2	10.0	4.3	2.3	56.4	169
Disc. 3-4 times/yr.	1.7	7.5	11.9	9.5	5.2	2.0	37.9	185
Mow &Disk 2/yr.	3.5	7.3	8.7	8.3	5.0	1.8	34.6	179

*Percent distribution feeder roots in grams per one foot square area to depth indicated.

(a) Total trunk growth in square centimeters between 1949 - 1958.

Under disk culture, few roots were present in the upper six inches of soil because the disking cuts the roots. Both non-tillage treatments using oil sprays to keep the soil bare and bermuda grass mowed frequently to provide a mulch cover induced prolific root growth in the upper six inches. These treatments also tended to increase roots in the 6-12 inch zone. Differences, in root concentrations did not exist between the 12" and 36" depth.

The marked reduction in roots below 30", which is similar to previous observations, is attributed to the calechi subsoil. Bermuda grass has increased the total number of feeder roots. These trees have produced less trunk growth. It appears that competition has increased root development at the expense of top growth.

Lemon Maturity Studies

This work was enlarged in 1959 to include six groves on the Yuma Mesa in addition to the previously tested five groves in the Salt River Valley. Growth of large, medium and small fruit was recorded from July to December and samples analyzed at approximately 3 week intervals after September 11.

At Yuma the average values showed the following changes occurred. Acid increased from 5.00% to 5.27% in November and decreased to 4.92% in December. Average acidity of fruit varied according to size as follows: Large 5.20%, Medium 5.12%, Small 5.01%. Both seasonal changes and differences between sizes are highly significant statistically, but the changes are not large. Juice content increased from 102 to 114 gal/ton between September 11 and October 21 and gradually increased to 117 gal/ton by mid-December. This increase plus the changes in acid resulted in a gradual increase in citric acid per ton from 45 lbs. in September to 52 lbs. during November. Values decreased between December 2 and December 16.

In the Salt River Valley the average values for acid increased from 5.88% on September 21 to 6.18% on October 26 and gradually decreased thereafter to 5.46% on December 21. Juice content increased from 107 gal/ton on September 21 to a maximum of 118 gal/ton in late October and did not change significantly thereafter. The pounds of citric acid/ton increased from 54 lbs. in September to 63 lbs. in late October and then gradually decreased to 56 lbs. in December. No consistent differences existed between sizes. In three groves small fruit contained less acid throughout the season; whereas in one grove small fruit contained more acid. In the fifth grove no differences occurred.

The lower acidity of the fruit in the Yuma area may be due to the Rough lemon rootstock. No differences in juice content exists between districts. The most favorable time to harvest lemons from the viewpoint of maximum pounds of citric acid per ton is in November in the Yuma area and between October 25 and November 15 in the Salt River Valley.

B. YUMA MESA

Valencia orange trees

Valencia orange trees (nine years old) have been given differential rates of nitrogen fertilizer since three years of age, including 1, 2, 3, and 4 pounds of nitrogen per tree per year. In the 1958-59 season, the average yields ranged from 81 lbs. for trees receiving 1 lb. of nitrogen to 106 lbs. for trees receiving 3 lbs. of nitrogen, which was a significant difference. Three and 4 lbs. of nitrogen resulted in lower fruit sizes, 4 lbs. of nitrogen resulted in a higher percent acid in the juice, while 2, 3, and 4 lbs. of nitrogen resulted in a lower Vitamin C content in the juice as compared with 1 lb. of nitrogen. Also the average rate of fruit growth was lowest for the trees receiving 2 lbs. of nitrogen per year. No significant differences were found between the irrigation treatments for the 1958-59 season, and the time of fruit maturity was not affected by any treatment.

These results indicate that for 9-year-old Valencia orange trees growing under these conditions (slightly silted Superstition Sand) three pounds of nitrogen per tree per year and the lowest rate of irrigation (irrigation at a tension of 500 to 600 cm. of water) meet the requirements for maximum yields and fruit quality.

Algerian Tangerine

Algerian tangerine (17 years old) and Washington Navel orange (13 years old) trees were treated with 80 ppm gibberellic acid sprays at start bloom and peak bloom, to find the effect of such sprays on fruit set. The sprays gave significant increases of fruit set (37% more than unsprayed) on the tangerine trees with

significantly higher fruit set on the peak bloom sprayed trees (57% more) as compared to the start bloom treatments. There were no significant results from the treatments on the Washington Navel orange. 2,4,5-T was applied to the same trees at 10 days and 6 weeks. There was a highly significant increase in "June-Drop" caused by the 2,4,5-T sprays on the tangerine. No significant results were found on the navels but the means would indicate a decrease in "June-Drop" resulting from the 2,4,5-T spray applied 6 weeks after peak bloom.

The results from this experiment indicate that gibberellic acid sprays when applied at peak bloom would increase fruit set on Algerian tangerine but at the present price of the material, the cost would be prohibitive for use on a commercial scale.

Lisbon Lemon

Lisbon Lemon trees on eight different rootstocks were planted in 1952. The 1959 bloom year yield showed the trees on Rough lemon and Rangpur lime to be highly significantly greater than the trees on Sour orange and Wilking Mandarin, but not significantly different from those on the other rootstocks.

The fruit analysis showed the fruit from trees on Rangpur lime had a highly significantly greater citric acid per ton than did the fruit from trees on Rough lemon. The trunk sizes showed no difference between the trees on Rangpur lime and Rough lemon rootstocks.

The 1959 yield data show that trees on Troyer citrange are yielding satisfactorily, their yields approaching that of Rough lemon and Rangpur lime. This is evidence that Troyer, as a rootstock, is reasonably well adapted to the Yuma Mesa conditions and may combine sufficient vigor with better fruit quality as has been found in California.

6. FACTORS AFFECTING THE SHIPPING QUALITY AND CONSUMER ACCEPTABILITY OF ARIZONA GROWN VEGETABLES.

Project Number: 308. Funds: Hatch and State. Personnel: P. M. Bessey, G. C. Sharples, R. E. Foster, W. D. Pew.

Lettuce pink-rib which develops after harvest was studied to determine effects of variety, season, transit and retail temperatures (under simulated conditions) and prepackaging. A test for chlorogenic acid (a polyphenol) which may be a precursor to pink rib was adapted to lettuce tissue and preliminary evaluations made. An experimental chemical senescence inhibitor was found to prolong shelf life of lettuce, carrots and broccoli. Lettuce head crushing and pink rib were evaluated as to head position in carton and method of packing. Preshipment treatments of cantaloupe fruit and storage temperature effects on market defects and shelf life were studied. Bitterness potential of Arizona carrots was determined.

Lettuce pink-rib was intensified by increasing storage temperature and prepackaging shortly after harvest. Differences between commercial lettuce varieties in pink-rib development were slight. Pink rib and bruising were correlated. Chemical disease protection for cantaloupes was effective at high transit temperatures.

7. RESPONSE OF CITRUS TREES TO SOIL MOISTURE: MOVEMENT OF SOIL MOISTURE IN THE ROOT ZONE.

Project Number: 371. Funds: Hatch and State. Personnel: R. H. Hilgeman, C. R. Everling.

Differential irrigation of old Valencia trees under the extremely unfavorable fruit set conditions in 1958 shows high soil moisture failed to increase yields. Highest yields were obtained from trees under stress the previous August and October. Shading a tree after mid-May did not improve fruit set. Water depletion at the 24-inch depth under 25-year-old Valencia trees on sour orange root appears to be similar at distances of 1, 4.3, 7.6 and 11 feet from the trunk. Root growth on young trees on Cleopatra mandarin root extended to 24 inches from the tree at a depth of 15 inches about 16 months after planting.

Leaf transpiration, loss of volume by the fruit, and leaf water deficits are all closely correlated with vapor pressure deficits when available moisture is present throughout the root zone. Such measurements provide factual information to rate treatments designed to change stresses.

8. CONTROL OF WEEDS IN LETTUCE AND CANTALOUPES.

Project Number: 374. Funds: Hatch and State. Personnel: W. D. Pew, James H. Park, U of A; H. Fred Arle, USDA, ARS.

LETTUCE

The use of Vegadex as a commercial herbicide for lettuce has been accepted by vegetable growers, but with some reservation. More information was needed on the effects of rainfall on effectiveness in controlling weeds, influence on the crop plants and method of application. Data collected this year indicate that there is an almost linear decrease in seedling emergence associated with an increase in days between application and the germination irrigation. However, the ultimate thinned stand was not significantly different between treatments. Likewise, yields were not widely variable up to a 4-day time lapse between application and germination irrigation. Head sizes were also not materially different.

With various application techniques using Vegadex and CIPC individually and in combination indicate that Vegadex gave better weed control than did CIPC. Further, the combination of CIPC and Vegadex was no more effective than Vegadex alone. In this test, no marked influence was observed when the treatment area was sprinkled or when the treatment material was applied at night.

These data confirm earlier findings and observations and provide more positive data relative to certain effects noted in commercial fields which must have been associated with other cultural factors or with climatic factors rather than herbicide effect. These data will encourage a wider use of Vegadex as a herbicide in lettuce production and thus reduce weed control costs.

CANTALOUPES

This test provides a re-evaluation of the currently recommended herbicide for cantaloupes, Alanap 3, with several new materials, Monsanto CP 10543, Herbisan and Eptam. The data indicate that Alanap 3, applied as a pre-emergence application, is the most effective of the materials tested. Monsanto CP 10543 induced chlorosis in the cotyledon leaves and provided only average weed control. Herbisan was neither effective on weeds nor did it adversely affect the crop plants. Eptam caused a definite puckering of the leaves that persisted well into the growing season. Yields were also markedly reduced. Likewise, Alanap 3 applied post-emergence reduced yield about the same as for Eptam, but weed control was good. Alanap 3 applied as pre-emergence gave good weed control and did not adversely affect yield. Effects of simulated rain verified the results found commercially; namely, a delay in germination and slowed early growth. This slower, early growth was largely overcome by harvest time.

Alanap 3 applied pre-emergence is currently being used on much of the cantaloupe acreage in the commercial planting in the Yuma area. Effectiveness of Alanap 3, when used commercially in accordance with findings in this and earlier tests, indicates the value in cutting weeding costs for commercial growers.

9. PROTECTION OF CITRUS TREES AND FRUIT FROM FREEZING INJURY.

Project Number: 384. Funds: Hatch and State. Personnel: R. H. Hilgeman, L. Burkhart, C. R. Everling.

In 1959 a single 16-foot, low-speed fan, ground-powered wind machine was acquired and one dual machine relocated so that 30 of the 40 acres at the citrus station are under protection. Use of liquid petroleum gas in all machines averaged 10 1/2 gal/hr which is about 50 percent more than gasoline consumption.

On the cold night of December 27 with average control temperatures of 29° F. with white frost (dew point 31° F.) and inversion of 6.5° F. the operation of the dual machines increased temperatures from 4.5° F. at the machines to 2° F. 300 feet away. The single machine produced lesser increases at the machine but equalled the 2° F. increase at 300 feet. A 2° F. or more increase occurred over about 22 of the 30 acres protected. Less than 2° occurred updrift from the machines and in a cold pocket between the machines.

An apparent leaf water deficit of 4.1% occurred in the leaves of a Valencia orange tree near the machine and a deficit of 3.5% of a tree 475 feet away. Leaf water deficits on unprotected trees were as follows: Valencia, 3.5%; tangerine, 3.1%; grapefruit, 1.8%; lemon, 1.5%. These values in general reflect normal frost tolerance and may represent an effective method of evaluating cold resistance. If such is the case, these data suggest that wind machines may alter the physiological condition of the leaves to induce greater frost tolerance.

10. PECAN PRODUCTION IN ARIZONA

Project Number: 398. Funds: Hatch and State. Personnel: J. R. Kuykendall, project leader; S. Fazio; L. Burkhart.

Alternate bearing habit for individual trees has been established on a basis of three years' yield records. Sixty-one percent of the Mahan trees exhibits this habit, and 1958 was generally the "on crop" years for most of the alternate bearing trees. Thirteen percent of the Burkett trees tend toward alternate bearing, and 1957 and 1959 were the "on crop" years for such trees.

Yield data for the three years 1957-1959 have been tabulated. Highest individual tree yields were 41.4 lbs. for a Mahan tree and 38.9 lbs. for a Burkett tree in 1959. Alternate bearing markedly affected total yield of husked nuts on 62 Mahan trees -- yielding 634.6 lbs. in 1958 the "on year" and 464.4 lbs. in 1959. Yield of husked Burkett nuts from 62 trees has increased steadily from 518.5 lbs. in 1957 to 1124.0 lbs. in 1959. Average yield per Mahan tree in "dry" plots was essentially the same as in "wet" plots in 1958 "on year" (14.7 lbs. vs 13.5 lbs.), but was higher on "dry" plot trees (23.7 lbs. vs 14.0 lbs.) in the 1959 "off year" crop. Very little difference was exhibited in average tree yield between "dry" plot and "wet" plot trees in any of the three years for the Burkett variety.

Stick-tight nuts and soil moisture: Combined data for 1958-59 indicated that 38% of all Mahan nuts harvested had stick-tight husks. In either year more stick-tight nuts occurred in the "on" or heavy crop year on any particular alternate bearing tree. In 1958 which was generally the "on crop" year for most of the Mahan trees, there was little difference between "wet" and "dry" plots with respect to percent stick-tight nuts (43.9% vs 45.5%), but in 1959 the "off crop" year, trees on "wet" plots had 55.4% stick-tight nuts compared with 30.4% stick-tight nuts on the "dry" plots.

11. LEMON PRODUCTION IMPROVEMENT.

Project Number: 405. Funds: Hatch and State. Personnel: D. R. Rodney and L. Burkhart.

Lemon Pruning Effects

Eureka lemon trees planted in 1947 have, since 1952, been pruned according to two different methods and these have been compared to unpruned controls.

Yields have been significantly affected by treatment in two of the last four years and in each of those years, the unpruned trees have had the greatest yields, while the trees pruned by removal of suckers have had lowest yields.

In 1959, the production on these trees was the heaviest in the history of the trees and there were remarkedly small differences between the yields of the three treatments. The yields in average number of boxes per tree were 15.6 for the unpruned trees, 15.2 for the trees pruned by heading back, and 15.1 for the trees pruned by removal of suckers.

Lemon Fertilizer Treatments

Lisbon lemon trees, 6 years of age, growing on unsilted superstition sand have annually received differential treatments including three rates of nitrogen, two rates of phosphate and two rates of manure. In each of the four years that the trees have produced measurable amounts of fruit, the average number of fruit per tree has been increased a small amount by applications of nitrogen fertilizer above the low rate, but large increases in numbers of fruit have resulted from the application of phosphate in addition to the higher rates of nitrogen.

The 1959 crop is the first commercial crop of fruit produced by these young trees. With the most productive treatments averaging five boxes or better per tree, compared to two and three boxes for the other treatments, the differences are of practical as well as statistical significance. Maximum yields in 1959 were obtained when phosphate was applied in addition to either of the nitrogen rates. Fruit analyses showed the greatest amount of citrus acid per ton of fruit and per acre when manure was applied at the intermediate nitrogen level.

12. GRAPE QUALITY.

Project Number: 343. Funds: State. Personnel: J. R. Kuykendall, project leader; G. C. Sharples, R. H. Hilgeman; L. F. True, H. F.Tate; (Agricultural Extension Service) and H. J. Phillips (Arizona Grape Growers Association). Cooperating.

Spraying gibberellin at either 10 or 40 ppm on Thompson seedless grape vines increased yield, cluster weight, and berry weight, but tended to decrease total soluble solids and acid in the berries. Applying sprays one week before end of flowering resulted in greatly reduced yield compared to spraying after flowering is complete. Normal practice of girdling Thompson seedless vines shortly after flowering results in higher yield and larger berries, but reduces total soluble solids compared with non-girdled vines. Late girdling of vines, one week before harvest, increases total soluble solids greatly, but reduces berry size. Spraying with 10 to 40 ppm gibberellin and then delaying girdling the vines until one week before harvest results in both larger berries and higher soluble solids than when vines are girdled after berry-set.

Cutting off 1/4" or 1" of the apex of Cardinal grape flower clusters just before flowering resulted in fruit clusters which were more compact and had better color than untipped clusters. Combined pack-out data for the first two pickings showed that flower cluster tipping produced a higher percent of No. 1 grade fruit and a lower percent of culls. There was no significant reduction in number of "shot-berries" or change in size of normal berries, but data indicated an improved set of high quality normal sized berries on treated clusters, and date of maturity was advanced.

Four hundred and sixteen (416) samples of Cardinal grapes, representative of fruit being shipped from the Salt River Valley were taken at all packing houses between June 11 and July 10. These samples were analyzed for total soluble solids and acid. The percentage of samples attaining 16% soluble solids were as follows: early season, (June 11 to 20) 37%; mid-season (June 21 to 29)70%; late season, (June 30 to July 10) 73%. Acid was exceptionally low with all samples after June 20 having below 0.7% acid. Average soluble solids values remained above 16% after June 22 in two of the three packing houses. Thompson seedless grapes were harvested between June 29 and July 11. Average daily values for soluble solids was above 16%, and acid values below 0.77% during this period. Preliminary tests showed the Exotic grape to be lower in soluble solids than Cardinal grapes.

13. FACTORS AFFECTING DECIDUOUS FRUIT CULTURE IN ARIZONA.

Project Number: 344. Funds: State. Personnel: P. M. Bessey, J. R. Kuykendall.

Seventy-four deciduous fruit varieties in the old orchard at Mesa were again evaluated for adaptation to warm winters (delayed foliation and blossoming periods) and productivity. Current variety recommendations for elevations up to 2500 feet are: peaches - Blazing Gold, Gold Dust, Robin, Springtime, Early Elberta; apricots- Earligold, Royal, Newcastle; plums - Santa Rosa, Beauty Mariposa, Duarte, Kelsey, Hollywood; apple - Transcendent crab; pear - Winter Bartlett, Keiffer, Lincoln; persimmon - Hachiya.

Ten potentially adapted varieties of early peaches and nectarines were added to the new deciduous variety test block at Mesa.

In a test of several minor element carriers applied to chlorotic apricots as foliar sprays, only Sequestrene 330 Iron showed any improvement in leaf color.

Continuous thermograph temperature records were obtained for the entire year.

A test of four kinds of planting holes in highly saline soil at the Safford Station was established to determine their influence on tree development.

14. VEGETABLE DIVERSIFICATION.

Project Number: 345. Funds: State. Personnel: W. P. Bemis, P. M. Bessey, H. C. Williamson, Jr.

Vegetable variety trials and cultural practices tested at the Yuma Valley Experiment Station.

Variety testing (tomatoes, spring and fall; squash; peppers; dry onions, slicing cucumbers, and carrots). Cultural testing, tomatoes (date of planting, mulching, winter protection, fruit set sprays, and spacing studies).

Vegetable tests at Yuma Valley Experiment Station will furnish data for the formulation of recommendations for that area.

Tabulation of temperature data from 10 stations by weeks for the thirty-year period ending in 1958:
Avg. Max; Avg. Min; Avg. Mean; Std. Dev. of Mean; Avg. H. U. (base 40°) Std. Dev. H. U.; Prob. of Temp. less than 20°, 32°, 45°, and 50°; Prob. of Temp. greater than 85°, 95°, 105°, and 115°.

Temperature data will be used as a guide to evaluate areas as to what kinds of vegetable crops can be tested and when during the season they should be tested.

15. PROPAGATION OF HORTICULTURAL MATERIALS.

Project Number: 349. Funds: State. Personnel: Steve Fazio.

The use of a mist system makes it possible to propagate plants under full sunlight thus inducing more rapid rooting of cuttings. It also allows the use of greenwood cuttings (3 to 4 weeks old) in place of more mature wood which may be more resistant to rooting. Coupled with the mist system is the use of concentrated rooting substances (500 ppm or more) used to soak cuttings for a period of 3 to 5 seconds before placing them in the rooting bench.

Eucalyptus is propagated commercially from seed. Variation in form and growth habit is a common occurrence with this method of propagation. Last fall a test was initiated to propagate eucalyptus from softwood cuttings under the mist system using a concentrated three second dip. Twenty-eight species were used in the test and results indicated that the grey foliage types are highly resistant to rooting in comparison to the dark green varieties. The green leaf varieties developed a vigorous root system and the grey foliage types formed callus at the cut end and at the nodes but failed to develop roots.

Use of mist systems for the propagation of horticultural plants in the arid desert regions of the southwest has excellent potentials for a new nursery industry. Nurserymen from the state of Arizona import over 50% of their stock from areas outside of Arizona. Nursery stock importation from other states is often prohibited by quarantine regulations and stocks may be in limited supply. Use of mist systems and concentrated growth regulators could make Arizona nurserymen independent of these outside sources of supply.

16. LANDSCAPE MATERIALS TESTING.

Project Number: 350. Funds: State. Personnel: J. S. Folkner, L. Burkhart.

A number of plants were started from both seeds and cuttings obtained in various collecting trips into Mexico on W-6 Domestic Exploration Funds. Outstanding are a prostrate clone of Lantana velutina, PI 262395, and the Pygmy Fan Palm, Erythea aculeata. The Lantana was increased sufficiently to release to the nursery trade December 10, 1959.

A Rose Test Garden in co-operation with the City of Tucson Parks Division has been established. Space has been prepared for 300 varieties of 10 plants each. Seventy-three named varieties were planted February, 1960, and, in addition, six numbered varieties for evaluation.

In cooperative experimental trials comparing different strains of Bermuda grass in the Tucson area, the Tifgreen hybrid proved superior to others tested. This strain has a more compact and prostrate type of growth and remains greener over a longer period into the fall season and regreens during warm periods in winter and is green earlier in the spring.

The Lantana and palm add two plants to the list of those available for landscape use in the Southwest. The Lantana and a native dichondra are proving new germ plasm for breeders working with these plants. The Tifgreen hybrid Bermuda, proven superior in experimental trials, is now being used in the Tucson Parks System.

17. GROWTH REGULATORS.

Project Number: 352. Funds: State. Personnel: J. R. Kuykendall, project leader; G. C. Sharples; D. R. Rodney; T. H. Hales; R. H. Hilgeman. L. F. True, H. F. Tate, C. G. Page (Agricultural Extension Service). Cooperating.

Algerian tangerine and Washington navel orange trees at the Yuma Citrus Experiment Station were sprayed at the start of bloom and at peak bloom with 80 ppm gibberellin to determine the effect of such sprays on fruit-set and yield.

The spray treatment produced a significant increase in fruit-set (37% more than on unsprayed trees) on the tangerine trees with a significantly higher fruit-set resulting from the peak bloom sprays (57% more than the start bloom sprays). There were no significant effects of the gibberellin sprays on the fruit-set of Washington navel orange trees, although there was a tendency for such sprays to reduce fruit-set. Part of the gibberellin sprayed trees were further sprayed with 2,4,5-T and 2,4,5-TP at 10 days and 6 weeks after peak bloom. These later compounds have been used in California to prevent "June Drop" on tangerine and navel orange trees. In our tests there was a highly significant increase in "June Drop" as a result of the combined gibberellin and 2,4,5-T sprays applied to tangerine trees. There was a tendency for both 2,4,5-T and 2,4,5-TP to reduce "June Drop" on the treated Washington navel orange trees when the sprays were applied 6 weeks after peak bloom.

Gibberellin sprays at concentrations of 20 ppm and 50 ppm were applied to Washington navel orange trees growing at the Salt River Valley Citrus Experiment Station. These sprays were applied at three dates: 5 weeks before full bloom; 1 week before full bloom; 5 days after full bloom. In all cases the gibberellin spray treatments decreased the set of fruit. The early sprays and higher concentrations reduced the yields more than the lower concentrations and later applied sprays.

Preliminary tests of chemical peach thinning were conducted in the 1959 season on three-and four-year old peach trees in an orchard in Cochise County. Several concentrations of two chemical growth regulators, naphyhyl phthalamic acid (NPA) and 3-chlorophenoxy propionic acid (PCPA), were applied at approximately one and two weeks following full bloom on seven varieties of peaches. Counts of fruit on tagged branches were made periodically during the season to determine the thinning effect of the treatments.

Effective thinning was obtained on three varieties and no reduction in number of fruit was obtained on two other varieties. On trees of two varieties, we counted more fruit on treated trees than on control trees, indicating the opposite effect of thinning.

These preliminary tests also indicate that higher concentrations of the chemicals may have to be used in our drier climate than are used in other parts of the country. However, concentrations of 400 to 500 ppm of PCPA did cause excessive thinning of fruit and some leaf damage. Sprays of 200 to 300 ppm of PCPA gave the best results. This is illustrated in the accompanying photograph.

On trees of varieties where the best thinning was observed, the growth regulators caused an appreciable drop of excess fruit within two to four weeks following treatment. Fruit which remained on the treated trees are larger in size than fruit on untreated trees.

Department of
PLANT BREEDING

1. A STUDY OF THE INHERITANCE OF FIBER QUALITIES IN SELFED LINES AND HYBRIDS OF UPLAND COTTON.

Project Number: 47. Funds: Hatch and State. Personnel: E. H. Pressley, Warner D. Fisher, C. D. Manderscheid and Jean L. Dykeman.

The five families of A-44 from which breeders seed have been obtained in the past were tested again in 1959. Subfamilies from plant selections out of these five families were also grown. Registered, foundation and breeders seed were included as checks. Results obtained from six of the 25 entries in this test are shown below.

Test of A-44 Families and Subfamilies

C R C 1959

Family No.	Yield % of A-44	% Lint	Length UHM	Fiber Strength	Fiber Fineness
A-44 Registered	100	34.9	1.10	3.42	4.63
A-44 Foundation	107	35.0	1.09	3.43	4.71
A-44 Breeders	107	35.0	1.12	3.38	4.79**
A-44-10-1	123	35.0	1.12	3.48	4.79**
A-44-10-16	122	35.4	1.10	3.47	4.90**
A-44-10-17	122	35.3	1.13**	3.48	4.91**

**Significant at 1% level.

All other entries shown in the table yielded higher than registered A-44. In terms of lint per acre, the yields of the subfamilies of A-44-10 were significantly higher at the 1% level. They were also significantly coarser than registered A-44. Their average length and strength were slightly greater but not significantly so. Another important factor in their favor is that of greater plant strength which reduces lodging and rotting of the lower bolls. The higher yields and coarser fiber of the foundation and breeders entries are probably due to the fact that in recent years selfed seed supplied to the Cotton Planting Seed Distributors has contained a higher percentage of A-44-10-16 and A-44-10-17 than was formerly the case.

There seems to be some improvement in the spinning performance of the A-44-10 subfamilies over registered A-44. This improvement shows up in stronger and better appearing yarns. The results of spinning tests made on the 1959 crop are shown below. The registered A-44 sample was not taken from the same test as the A-44-10 subfamilies, but from another test grown in the same field.

Entry	Staple Length	Yarn Strength 22s	Yarn Strength 50s	Nep Count	Yarn* Appearance
A-44 Registered	1 3/32	122.2	43.3	4	100
A-44-10-1	1 1/8	134.6	47.6	5	110
A-44-10-16	1 1/8	128.5	46.2	3	110
A-44-10-17	1 1/8	131.8	45.6	5	105

*100-Average.

Due to higher yields and better spinning performance, selfed seed supplied to the Cotton Planting Seed Distributors in 1960 will be made up of equal parts of A-44-10-1, A-44-10-16 and A-44-10-17. This practice will continue until better selections are found. Planting seed from this source should fill all demands by 1963.

Sixty-one sixth generation strains were grown at Yuma, the Cotton Research Center and Marana in 1959. At each location, A-44, A-44 WR and 4-42 WR were included as checks. Eighteen of these gave higher yields than A-44 at Yuma, fifty at the Cotton Center and fourteen at Marana. Thirty-six of the selections averaged higher in yield at Yuma and the Cotton Center, while thirty-four averaged higher at all locations. Of twenty strains sent to College Station, Texas for spinning, nineteen averaged higher in yield at the three locations than did registered A-44.

Yields and fiber data for the strains spun are shown below in comparison with registered A-44.

Strain No.	Yield % of A-44	% Lint	Length UHM	Fiber Strength	Fiber Fineness
212-13-2-2-3	118.0	33.6	1.13	4.02	4.43
231-13-4-11-3	116.8	35.9	1.10	3.94	4.74
221-7-3-5-5	116.4	34.7	1.15	3.79	5.25
209-4-4-2-6	112.0	35.6	1.12	3.83	4.67
231-13-4-11-8	109.8	36.2	1.09	3.82	4.94
227-12-1-4-11	109.5	35.0	1.11	3.96	5.16
231-13-4-11-1	108.4	36.4	1.10	3.98	4.74
228-1-3-2-1	108.3	37.2	1.10	3.84	4.99
209-4-4-2-5	108.0	36.4	1.13	4.02	4.98
220-10-3-7-1	107.2	35.2	1.10	4.13	4.80
209-4-4-2-1	107.0	36.3	1.14	3.91	4.52
209-4-4-2-8	106.5	36.0	1.13	3.97	4.89
231-17-1-1-5	106.1	34.7	1.11	3.67	4.79
213-10-4-3-4	105.6	35.1	1.13	3.75	4.70
227-12-1-4-4	103.9	34.6	1.12	4.09	4.97
231-13-2-2-1	102.6	35.8	1.12	3.77	4.72
209-4-4-2-2	102.6	35.5	1.14	3.97	4.62
205-3-3-3-9	101.8	34.3	1.19	4.21	4.74
231-17-1-1-1	101.6	35.5	1.10	3.82	4.61
206-10-2-2-1	96.4	35.4	1.16	4.31	4.96
A-44 Registered	100.0	34.5	1.09	3.45	4.59

The average yield of registered A-44 at the three locations is taken as 100.0%. The average yield of each strain is then shown as a percentage of this figure. All other values in the table are from samples grown on the Cotton Research Farm.

Spinning values for the twenty strains and registered A-44 are shown below.

Strain No.	Staple Length	Yarn Strength 22s	Yarn Strength 50s	Nep Count	Yarn* Appearance
212-13-2-2-3	1 1/8	149.4	52.8	3	110
231-13-4-11-3	1 3/32	146.2	51.0	2	115
221-7-3-5-5	1 1/8	141.9	50.4	3	120
209-4-4-2-6	1 1/8	148.2	50.9	2	115
231-13-4-11-8	1 1/8	140.4	49.6	1	120
227-12-1-4-11	1 1/8	144.9	50.9	4	110
231-13-4-11-1	1 3/32	146.9	52.4	3	120
228-1-3-2-1	1 3/32	141.6	48.4	2	120
209-4-4-2-5	1 1/8	146.1	52.0	1	115
220-10-3-7-1	1 1/8	151.3	53.2	5	110
209-4-4-2-1	1 1/8	150.6	52.9	3	105
209-4-4-2-8	1 1/8	149.6	50.8	3	115
231-17-1-1-5	1 3/32	138.0	49.2	5	115
213-10-4-3-4	1 1/8	135.1	46.2	2	110
227-12-1-4-4	1 1/8	153.3	55.1	2	120
231-13-2-2-1	1 1/8	144.5	51.0	3	115
209-4-4-2-2	1 1/8	150.9	53.2	3	110
205-3-3-3-9	1 1/8	149.6	53.6	1	115
231-17-1-1-1	1 3/32	143.6	51.2	3	115
206-10-2-2-1	1 1/8	155.4	54.5	1	120
A-44 Registered	1 3/32	122.2	43.3	4	100

*100-Average; 110-Good; 120-Very Good.

Judging by yarn appearance, the number of neps per 100 square inches of card web, and the strength of both 22s and 50s yarns, these are the best results ever obtained on strains or varieties of upland cotton grown by the department. Six of the strains were given yarn appearance ratings of 120, or very good. This means a "B+" for both 22s and 50s yarns--something never attained in the past.

2. BREEDING COTTON FOR DISEASE AND INSECT RESISTANCE WITH PARTICULAR EMPHASIS ON VERTICILLIUM WILT AND FOR PLANT TYPES SUITABLE FOR MECHANICAL HARVESTING.

Project Number: 278 (S-1). Funds: Hatch and State. Personnel: Warner D. Fisher, E. H. Pressley, H. Muramoto, C. D. Manderscheid, Jean Dykeman, Lester M. Blank, A.R.S.

For the past several years the major emphasis of this project has been placed on the development of cotton with tolerance on resistance to Verticillium Wilt. In 1959 this work was conducted on the University farm at Marana where wilt has become increasingly severe in recent years. Tests of the seven strains currently constituting the Breeder's seed increase of the 44 WR variety indicated no consistent differences in yield or fiber quality in 1959. As a result no change in the composition of this variety is indicated. Nine additional selections out of 44 WR were also tested at Marana. Four of these lines were superior to 44 WR in both yield and wilt tolerance but unfortunately were inferior to 44 WR in fiber quality, especially fiber strength.

Sixty advanced strains developed primarily for non-wilt areas were tested at Marana in 1959. Nine of these strains yielded as well or slightly better than 44 WR and were rated about equal to 44 WR in wilt tolerance. Yield and spinning performance of three of these lines compared to 44 WR are shown below:

STRAIN	YIELD LINT/ACRE	STRENGTH OF 22'S YARN	NEP RATING*
231-17-1-1-5	853	146.7	1.7
231-13-4-11-3	853	151.0	2.0
231-13-4-11-1	788	151.5	2.0
44 WR	771	138.2	2.5

* 1 - 0-6 Neps per 100 square inches card web

2 - 7-12 Neps per 100 square inches card web

3 - 13-24 Neps per 100 square inches card web

Approximately 550 individual plant selections were made from F_3 and F_4 progeny rows. About 125 of these selections survived laboratory tests and will be continued in 1960. Twenty lines in the fourth or later generation showed sufficient promise to be included in a yield test in 1960.

Included in this project for the first time is a report on breeding cotton for low gossypol in the seed. Gossypol is objectionable in cotton seed because cottonseed meal containing gossypol is toxic to poultry and swine. In addition gossypol increases the cost of refining cottonseed oil. The gossypol content of the seed is closely associated with the glands found in the cotyledons. A line free of glands in the cotyledons was obtained from S. C. Mc Michael, Agricultural Research Service, Shafter, California and crosses with 44 WR were made in 1958. These crosses were sent to Iguala, Mexico for winter increase and the F_2 population was planted at Tucson in 1959. Plant selections for the glandless character were made by examining the cotyledons and hypocotyl for the absence of glands. Out of 3,170 plants examined, 214 were glandless. These glandless plants were backcrossed to seven 44 WR Lines and these again sent to Iguala for selfing and increase. Glandless plants will again be selected in 1960 and backcrossed to the recurrent parent (44 WR). The ratio of glanded plants (2,956) to glandless (214) is approximately 15.1 suggesting 2 pairs of genes as controlling the inheritance of this character. However, the failure to recover certain phenotypic classes expected on the assumption of simple dominance and independent assortment casts some doubt on the validity of the above hypothesis. An alternate hypothesis based on quantitative inheritance with preferential appearance of glands on the hypocotyl and cotyledons was proposed. The difficulty of field classification with respect to density and location of glands makes some other method of classification highly desirable An attempt to bleach out the chlorophyll and differentially stain the glands for photographing was made. To date a satisfactory staining technique has not been fully developed. When such a technique is perfected, colored slides can be made of each segregate. These can then be projected and scored much more accurately. The resulting classification should lead to a more accurate and complete understanding of the genetics of the glandless character.

3. BREEDING LONG STAPLE COTTON (GOSSYPIUM BARBADENSE) FOR LENGTH, FINENESS, AND STRENGTH OF FIBER AND IMPROVED TYPE OF PLANT WITH HIGH PRODUCTION.

Project Number: 294. Funds: Hatch and State. Personnel: W. E. Bryan and H. Muramoto.

(W. E. Bryan)
The following selections were grown in 1959:

(a) Twenty-one selections, selected for yield and lint quality and grown in 500 ft. and 100 ft. rows.
(b) Approximately 9000 F_6 plants grown in rows 6 ft. apart with the plants 2 ft. apart in the row. These 9000 plants constitute the F_6 generation of a composite derived from 13 crosses whose parents (some 28 in number) represent the entire range of characters in cultivated cotton, including upland and barbadense.
(c) Four hundred individual plant selections from this composite were made in the field in the fall of 1959 on the basis of yield, length of lint, and boll size. These 400 plant selections were mixed in the seed cotton stage, the seed of which is being used for planting the 1960 crop of the composite.

(d) A spinning test was made of the lint obtained from the 400 plant selections mixed in (c) above, in comparison with Pima S-1. In fiber length, fiber strength, and yarn appearance, the composite was comparable to Pima S-1, though somewhat weaker in yarn strength in 36's and 60's.
(e) Seven additional crosses were made in 1959 in order to produce further desirable combinations of lint and yield characters.

(H. Muramoto)
The following cottons were grown in 1959:

(a) Genetic combining ability test.
  (1) 36 plots of 6th generation selfed progenies of Composite B (CB)
  (2) 36 plots of F_1 generation of crosses between CB's and 13-1
  (3) 36 plots of F_1 generation of crosses between CB's and #70
  (4) 12 plots of commercial Pima S-1 used as checks.
  (5) 30 plots of 13-1
  (6) 20 plots of #70
(b) Row spacing test - advanced progenies.
  (1) Six replications of Pima S-1, 2-2-2, and CB-58 were planted in 40" and 80" row spacing in a split-plot design.
(c) Progeny rows from single plant selections.
(d) The following work was done with the cotton listed under a, b, and c above:
  (1) Yield and fiber data were taken.
    a. The combining ability test showed the definite grouping of high and low combiners for yield. High yielding strains were better combiners. Some outside row effects were present. Most of the high combiners have already been selected to make CB-58.
    b. The row spacing test showed 40" row spacing gave significantly higher yields than the 80" row spacing per unit area. 2-2-2 and CB-58 gave higher yields than Pima S-1. No differences in plant type were observed.

(W. E. Bryan)
Further selections in the composite and in the crosses made in 1959. Lint quality and yield will be studied in these selections.

(H. Muramoto)
(a) Higher combiners that are not already in CB-58 will be studied.
(b) Row spacing test will be repeated again this year.
(c) Plants selected from progeny rows will be planted for further selections in 1960. Emphasis will be toward dwarf type plants and their progenies.

4. IMPROVEMENT AND MANAGEMENT OF FORAGE SORGHUM

Project Number: 492. Funds: Hatch and State. Personnel: R. L. Voigt. (In cooperation with University Experimental Farms.)

The result of the 1959 Forage Sorghum Research Program can be summarized as follows:

1. 15 varieties and hybrids of forage sorghums were tested at 3 experimental farms in 1959 for forage yield (at 70% moisture) height, lodging, maturity and chemical composition. Two of the tests were planted at Tucson and Yuma in June and July respectively for single harvest. At Mesa the entries were planted in March for double harvest and in June at Mesa, Tucson and Yuma for single harvest.

2. Among the hybrids, double harvest increased their total yields 13% over single harvest compared to 38% increase by double harvest of the varieties. Hybrids outyielded varieties 9.4% on double cutting at Mesa, and at all 3 locations, 26% to 34% over varieties on single cuttings.

3. There was considerable lodging in nearly all varieties and hybrids at Yuma with the least at Mesa. The lodging problem may be partially controlled by using early maturing or short sorghums. Hegari is a favorite forage sorghum for silage purposes due to its short height and consequent low lodging as well as grain. Hybrids generally produce greater yields and should be used where lodging is not a problem such as in areas of shorter growing seasons. The forage sorghums have been grouped in general categories of early, mid-season, and late maturity for purposes of making recommendations to farmers in different areas of the state.

4. 10 Sudangrass varieties and hybrids were yield tested at Tucson in 4 replications. The forage cuttings were made periodically to simulate rotational grazing conditions. California #23 and a hybrid DeKalb SX-11 were highest in total dry matter yield.

5. The moisture samples from all of the forage sorghum and sudangrass tests were saved to be ground and analyzed for chemical content which have not yet been completed. The chemical analyses will be for digestible laboratory nutrients as a measure of feeding value.

6. Some crosses onto male steriles carried out in the field.

5. IMPROVEMENT AND MANAGEMENT OF GRAIN SORGHUM.

Project Number: 493. Funds: Hatch and State. Personnel: Lee S. Stith (In cooperation with Dr. T. C. Tucker-Agricultural Chemistry and Soils; H. E. Jacka-Arizona Crop Improvement Association; Dr. Paul D. Keener-Plant Pathology Department; University Experimental Farm.)

The results of the 1959 Sorghum Research Program can be summarized as follows:

AGRONOMIC STUDIES

(a) Double harvest tests were conducted at Yuma and Mesa which included studying the interaction of variety, row width, and method of management. Birds destroyed the second crop at Yuma. Amak R-10, RS 610 and DD 38 were grown in 18 and 36 inch rows and treated in 4 systems. Treatment 1 was to harvest in July, leave at combine height for regrowth and harvest in November. Treatment 2 was to harvest in July, plow and replant; Treatment 3 was to harvest in July, mow back to ground level before start of regrowth and harvest in November; Treatment 4 was to omit the July harvest, cutting in November only. Results are shown in appropriate table.

(1) Yield Comparing Treatments

Treatment 1 = 100%

		TRT 1	TRT 2	TRT 3	TRT 4
Amak R-10	18"	100	69.1	93.1	99.9
	36"	100	68.2	95.3	93.3
RS 610	18"	100	68.5	91.4	100.7
	36"	100	64.6	90.1	82.6
DD 38	18"	100	65.8	94.7	81.5
	36"	100	67.5	98.0	82.9

(2) Comparison of 18" versus 36" rows

Yields by Row Spacing and Treatments--18" row = 100%

		TRT 1	TRT 2	TRT 3	TRT 4
Amak R-10	18"	100	100	100	100
	36"	95.6	94.3	97.9	89.3
RS 610	18"	100	100	100	100
	36"	98	92.5	96.7	80.4
DD 38	18"	100	100	100	100
	36"	89.3	91.6	92.5	90.9

(3) Yield by Varieties and Treatments

Pounds per acre

		TRT 1	TRT 2	TRT 3	TRT 4
Amak R-10	18"	8601	5947	8007	8592
	36"	8226	5609	7842	7673
RS 610	18"	8414	5759	7682	8461
	36"	8245	5328	7429	6810
DD 38	18"	8836	5816	8367	7204
	36"	7898	5328	7738	6547

(b) Soil studies conducted in cooperation with Dr. T. C. Tucker indicates:
(1) Nitrogen will increase yield in most areas
(2) Organic matter is needed on Mesa Farm
(3) Phosphate will generally not give a response

(c) Yield tests again verified the superiority of hybrids in yield over standard varieties. The date maturity group yield best at the higher elevations, the mid-season maturity growth in the Salt River Valley, and that the correct growth for the Yuma area is not definitely known.

(d) Preliminary tests with a March planting of male sterile seed with appropriate pollinator set seed in the Wellton Area.

PATHOLCGICAL

(a) Virus studies were made at the Mesa Farm. Dr. Paul Keener evaluated the 80 entries and rated them for resistance or susceptibility. Differences were noted and recorded.

(b) Dr. Keener also conducted laboratory tests at Tucson for further identification of the diseases.

BREEDING WORK

(a) Nursery was maintained at the Campbell Avenue Farm.
(b) Backcrosses were made to increase good steriles.
(c) Crosses made to evaluate the use of quadruple dwarf stocks in hybrid production.
(d) F_1 material from previous year was evaluated.

Department of
PLANT PATHOLOGY

1. CONTROL OF PHYMATOTRICHUM (COTTON OR TEXAS) ROOT ROT IN IRRIGATED LANDS.

Project Number: 42. Funds: Hatch and State. Personnel: R. B. Streets, R. M. Allen.

Cotton and other summer annual crops: Watermelon has been added to the list of susceptible annual crops (cotton, castor beans, soy beans and cowpeas) for which the most practical control is a winter, green manure crop of Papago peas.

Chemical control: So far no chemical has shown promising eradicant effect. Borders uniformly and severely infested are maintained for field tests.

Alfalfa: A few of the progenies grown on one of our uniformly and severely infested borders survived the first season. Another border is being planted to additional progenies in hope of securing root-rot resistant strains. This work will be reported in more detail under Hatch 227 by Dr. Keener and Dr. Schonhorst.

Stone fruit trees: Root rot has not yet been controlled in stone fruit orchards. A third year with applications of surface mulches plus organic matter in holes has given very encouraging results in a thrifty 5-year-old planting of peaches, apricots, and plums.

We recommend a winter-grown green manure crop of Papago peas before planting cotton, castor beans, soybeans or cowpeas, or watermelons on root-rot infested land.

Use of organic matter in holes, and mulches, and ammonium sulphate and sulphur is recommended as the best available treatment for root rot in stone fruit plantings.

2. CONTROL OF ROOT DISEASES AND VIRUS DISEASES OF CITRUS.

Project Number: 222. Funds: Hatch and State. Personnel: Ross M. Allen, H. H. McDonald, D. R. Rodney, U. of A. and John B. Carpenter, U.S.D.A.

The citrus virus indexing program is being continued and has been expanded by 2,000 seedlings from hotbed propagations. Trial index series have been established in field and screenhouse for development and improvement of techniques and for study of known virus diseases under Yuma conditions. Several new varieties, for eventual distribution to growers, have been propagated at Yuma following importation from California by Dr. Carpenter. A field test has been started in a young citrus grove in an attempt to reproduce dry root-rot disease which caused substantial local losses this past year. Long term studies of Stubborn Disease in Grapefruit are being continued.

3. DISEASES OF ROOTS AND ROOT-CROWNS OF ALFALFAS IN ARIZONA INDUCED BY SOIL-INHABITING PATHOGENS.

Project Number: 227. Funds: Hatch and State. Personnel: Paul D. Keener, Department of Plant Pathology; Melvin Schonhorst, Department of Agronomy.

1200 cuttings from clonal lines, chosen because of their resistance to the spotted alfalfa aphid and yielding qualities, were studied for possible resistance to the crown- and root-rot pathogens existing in soils of the State. Approximately 70 per cent of these failed to show any appreciable resistance to the Phymatotrichum omnivorum -Rhizoctonia complex, which is the usual one found in Arizona. Fusaria spp. were found in approximately 20 per cent of the diseased roots. The latter group of fungi were more common at Tucson than at Mesa. At Mesa, the complex usually consists of Phymatotrichum omnivorum-Rhizoctonia.

Several of the lines showed susceptibility to Downy Mildew, caused by Peronospora trifoliorum.

Some of the virus infections caused severe stunting of plants and in general studies indicate that the importance of these pathogens cannot be overemphasized. Many virus-infected plants were also invaded by bacteria and fungi, particularly the bacterial wilt organism, Corynebacterium insidiosum, and crown-rot vs. root-rot pathogens.

Ladak, a variety of alfalfa normally resistant to the bacterial with pathogen, was found to be very susceptible to the Phymatotrichum-Rhizoctonia complex. Almost 100 per cent kill was noted in soils in plots formerly used for studies on cotton root-rot, at the Mesa Station.

Moapa, one of the more recently introduced alfalfas, showed considerable susceptibility to Peronospora trifoliorum in the Salt River Valley during 1958 and 1959. This variety is also highly susceptible to mosaic viruses, including both alfalfa mosaic (Marmor medicaginis) and cucumber mosaic (Marmor cucumeris).

Ranger continues to show susceptibility to leaf rust, Uromyces striatus, especially in the Southwestern portion of the State.

Although climatic factors appeared to be ideal for such outbreaks, very little infection from the 3 leafspot types found in the State was noticeable (i.e., from Ascochyta, Psuedopeziza and Pseudophlea spp.).

Alfalfa dwarf virus (Morsus suffodiens) appeared in several plantings in 1959. This virus causes the disease of Grapevines known as Pierce's disease.

Big-bud Virus (Chlorogenus australiensis) was observed on two tomato plants at Tucson. This is the first record of this disease for the Tucson area. Big-bud has been prevalent in some years in Cochise and in Maricopa counties. The virus causing big-bud is also suspected of being related to alfalfa phyllody and witches'-broom viruses.

4. VERTICILLIUM WILT OF COTTON

Project Number: 256. Funds: Hatch and State. Personnel: Ross M. Allen, H. H. McDonald, U. of A.; and John Chapman, Agr. Extension Service, Yuma County.

Fourteen additional fields in the Yuma Valley have been found to be infested with Verticillium. Cotton plant infections ranged from less than 1 percent to 16.4 percent. Greatest amounts of disease occurred in fields where rows were arranged in the North-South direction. Adjacent fields of similar crop history, but where row direction was East-West, were usually less affected by wilt. Foliar symptoms in cotton in Yuma disappear with the onset of hot weather and do not recur in Fall, as in other Verticillium infested areas of Arizona. All known locations of the disease in the Yuma area are adjacent to drainage systems or large irrigation laterals. Severe incidence of Verticillium in cantaloup was noted for the first time this past year.

5. THE CAUSE AND CONTROL OF CANTALOUP CROWN BLIGHT.

Project Number: 317. Funds: State. Personnel: R. B. Marlatt, R. T. McKittrick.

Nematodes Associated With Cantaloups In Desert Soils.

Eighty-two soil and root samples from crown-blighted and healty vines were collected from eleven cantaloup fields in Yuma Valley. Nematodes were collected by the use of Baermann funnels and suspensions were concentrated with a newly devised filtering apparatus which accomplished in 15 minutes that which would have required three hours by usual methods. Vials containing preserved nematodes were sent to the U.S.D.A. nematology laboratory at the Cotton Research Center, Tempe, and to Dr. D. J. Morton, North Dakota Agr. Expt. Sta., Fargo, North Dakota for identification. Results were analyzed statistically.

Nematode genera which were recovered and may have been parasitic included (in order of decreasing numbers): Aphelenchus, Tylenchorhynchus, Pratylenchus and Trichodorus. There was no apparent correlation of these four genera with crown blight in the field nor with dying of leaves in the greenhouse. Very few of these parasitic types were found.

Predominating non-parasitic genera recovered, listed in order of decreasing numbers, included: Acrobeles, Rhabditis, Cephalobus, Dorylaimus, Prismatolaimus and Eucephalobus. There were significantly more nematodes in soil under healthy vines than in soil beneath crown-blighted plants.

Extracting nematodes from root samples gave generally the same results as from soil samples. In fact root samples showed less variability than soils even though soils were weighed to 100 grams and roots were of various weights and sizes.

Soil Transmission

In conjunction with the nematode experiment enough soil was collected in each sample to fill an 8-inch pot. Cantaloups were grown in the 82 soils in the greenhouse and examined periodically for crown-blight.

Most plants expressed yellow-type symptoms and some showed gray-green while others showed brown type symptoms.

The dates when cotyledons died were recorded and it was found that cotyledon dying was not directly related to a soil source with crown-blight history.

By counting the total leaves on a main runner and the number one-half or more dead, a "percentage dead" figure was calculated as an estimate of crown-blight severity. There were no significant differences in amounts of crown blight on greenhouse vines in "crown-blight" soil as compared to plants in "healthy" soil. This was further evidence that crown blight was not transmitted in soil.

A third crown-blight investigation, a field experiment, was ruined by a hail storm on the Mesa Experimental Farm.

6. CONTROL OF CROWN BLIGHT OF CANTALOUPS.

Project Number: 317. Funds: State Research. Personnel: Merritt R. Nelson, Ross M. Allen, Herbert H. McDonald and Donald M. Tuttle, U. of A.

Cantaloup plantings made at bi-weekly intervals from (January 15 to March 15) showed less crown blight in the two earliest dates. Initial appearance of, and total infection by virus occurred first in the early plantings. Granular Thimet application in seedrows of some plots gave no differences over untreated plots.

Cantaloups following fall-planted Papago Peas (green manure crop) had less crown blight than those in plots amended by steer manure or calcium cyanamide or in plots dry-fallowed. Papago Peas and steer manure amendments produced plants having more living runner tips than did the other two treatments.

Commercial type turning and sanitized turning of cantaloupe vines resulted in higher yields of marketable melons than treatments including no handling, rough handling, sanitized pruning and non-sanitized pruning.

A barrier-trap crop (safflower) showed promise of protecting adjacent cantaloupes from virus infection. Aphid vectors appeared attracted to safflower in preference to cantaloupe.

Screen cages (32x32 mesh) placed over field-grown cantaloupes prevented natural virus infection. Cage-grown plants inoculated with viruses became infected, but showed no more crown blight than non-infected plants.

Virus isolates obtained from cantaloupes during the season were mostly watermelon mosaic. Cucumber mosaic virus infections though numerous, were less prevalent.

7. ANTIBIOTICS IN RELATION TO PLANT DISEASE CONTROL.

Project number: 359. Funds: State. Personnel: Alice Boyle, R. B. Streets.

(1) Work on the prevention of crown-gall has been continued.

The hope that tetracycline Hcl would prevent crown-gall under field conditions by retaining its effectiveness longer than the previously used streptomycin-terramycin, proved false. The antibiotic is rapidly inactivated in non-sterile soils.

Laboratory and greenhouse testing of other antibiotics showed one, Vancomycin Hcl, to have great promise. It is unusually stable; it is readily absorbed through leaves and stems as well as roots; rapidly builds up to effective levels (500 mg/ml); is translocated both upward and downward in plants, and is non-phytotoxic at very high concentrations to all plants used in tests.

Two experiments to test the usefulness of Vancomycin in crown-gall prevention have been established. (1) Greenhouse test using rose cuttings, three root stocks (Burr, Shafter and Manetti) (2) Field test with cuttings at Campbell Avenue Farm.

Inoculation experiments with material from small overgrowths on commercial roses condemned by State inspectors proved that these were indeed young crown-galls.

(2) The antibiotic Acti-dione has been found to control "Grease-spot" of turf caused by Pythium aphanidermatum.

No recommendations can be made as yet for the use of Vancomycin as a crown-gall preventative.

The "Grease-spot" disease has been an important problem to greenskeepers in the state so its control with Acti-dione has been useful to them.

8. DIAGNOSES OF PLANT DISEASES.

Project Number: 360. Funds: State. Personnel: Alice Boyle, R. B. Streets.

County agents, nurserymen, growers, and home owners have brought or sent to the laboratory over 600 specimens of diseased plants. These have been reported upon directly to the person or by phone or letter. In many cases culturing of diseased plant tissue was necessary and often inoculations were required to establish the cause of disease.

Study of Verticillium wilt of olive was continued during the year. Isolates of Verticillium albo-atrum from cotton were found not to produce the disease in olive. Negative results were obtained when the olive isolate was inoculated into tomato-pepper, okra, eggplant, cucumber, cotton, and safflower.

The following diseases have been noted for the first time:

A Phytophthora root-rot of Magnolia
Phymatotrichum root-rot of Ocotillo

The great increase in the use of weedkillers in recent years has created an additional "plant disease" problem especially in the case of home plantings where intensive culture is practiced. Selective weed killers applied to lawns and other areas are leached into the soil by watering and are picked up by the roots of trees and shrubs, and have caused serious damage. Also, the "permanent" weed killers

such as arsenate and borate mixtures now being applied so freely to driveways, gutters, alleys, and soil under brick or tile terrace and patio pavements are intended to sterilize the soil permanently or for a long time. Any roots reached by rain or irrigation water percolating through treated soil are injured or killed. Among the more sensitive shade trees and ornamentals are olive, umbrella tree, pines, privets, trumpet vine, roses, grapes, and zinnias.

9. DISEASES OF GRASSES IN ARIZONA.

Project Number: 378. Funds: State. Personnel: Alice Boyle.

Much of the work of the past year has consisted of identification of diseases and control recommendations for greenskeepers, parks superintendents, and home owners.

Tiff-green, a hybrid Bermuda, proved more resistant to disease than any of the hybrids previously tested.

Several wide spectrum turf fungicides have given outstanding disease control: Mallinckrant's NF-30 and MFG-Type A, and California Spray-Chemical Corporation's Ortho Lawn Fungicide. The latter is particularly effective against the destructive Fusarium blight of winter lawns.

Work planned for next year:

(a) In cooperation with the Department of Agricultural Chemistry and Soils: Effect of nitrogen source and certain trace elements upon disease incidence and recovery from disease after treatment. Start work on relation of certain physical properties of soil to disease incidence and recovery from disease.

(b) In cooperation with Agronomy Department (Dr. Baltensperger): Testing of newly-developed lawn grasses for disease resistance.

(c) Testing new fungicides.

10. CHEMICAL CONTROL OF NEMATODES AFFECTING VEGETABLES.

Project Number: 406. Funds: Hatch and State. Personnel: Merritt R. Nelson, Herbert H. McDonald, U. of A., and Harold Reynolds and John O'Bannon, U.S.D.A.

Four different nematicides were used to fumigate plots in a replicated test of their effectiveness against root knot nematodes in cantaloupes. Plots were fumigated with the following materials at the indicated rates: dichloropropanes-dichloropropenes, 100 percent, 25 gpa; ethylene dibromide, 85 percent, 8 gpa; 1,2-dibromo-3-chloropropane, 50 percent, 8 gpa; 1,2-dibromo-3-chloropropane, 50 percent, 4 gpa; and 1,3-dichloropropene and related C_3 hydrocarbons, 100 percent, 25 gpa. Data will be taken in May and June 1960 including estimates of plant condition, yield and root knot index.

A second experiment is underway to test the effectiveness of several nematicides against root knot nematodes affecting tomatoes. This nematicide trial will include several rates of ethylene dibromide (previously showed to be very effective against root knot nematodes in tomatoes) and placement studies with this and other nematicides.

11. WOOD-NECROSIS GUMMOSIS OF CITRUS.

Project Number: 407. Funds: Hatch and State. Personnel: Ross M. Allen, Merritt R. Nelson and H. H. McDonald, U. of A.

Five organisms isolated from grapefruit affected by wood-necrosis gummosis have been inoculated into old grapefruit trees. Several modifications of inoculation techniques have been tried. The most frequently isolated organism has been subjected to a number of cultural studies. This organism, an unidentified basidiomycete, is now known to function equally well under conditions of high or low oxygen concentrations. The only sporulation obtained was from dung cultures. Efforts to germinate spores by several methods gave negative results. The organism grows best under conditions of relatively high temperature (30-34° C.), and required media rich in plant extracts. A grove planting of 114 young, Frost Nucellar Marsh grapefruit trees has been propagated for future use in studying this disease.

12. CONTROL OF MILDEWS OF LETTUCE.

Project Number: 408. Funds: Hatch and State. Personnel: R. B. Marlatt, R. T. McKittrick.

Time of Infection

It would be important to know the average stage of growth during which lettuce is infected with downy mildew in the field. If lettuce is infected when young and sporulation of the fungus is delayed until climatic conditions are favorable, early control measures may be needed. If most infection occurs during an epiphytotic, fungicide applications may be delayed until early signs of disease appear in the area.

Forty-eight lettuce plants were collected every three weeks or so from each of seven fields in the Salt River Valley. They were transplanted to paper containers and kept alive in a greenhouse for three weeks where temperature and humidity were favorable for downy mildew infection and sporulation.

All leaves on each plant were examined for downy mildew. No mildew was found on plants from any of the fields and none was found in any fields observed.

Fungicides

Two fungicides which were most promising for downy mildew control were evaluated in seven commercial lettuce fields in the Salt River Valley. Applications were made of zineb, four pounds per 100 gallons of water and of basic copper sulfate, eight pounds per 100 gal., in replicated experiments.

No downy mildew occurred in any of the fields and incidences of other diseases were not great enough to permit making comparisons.

13. CONTROL OF MILDEWS OF LETTUCE AND CANTALOUPES.

Project Number: 408. Funds: Grant-In-Aid from California Spray Chemical Corporation. Personnel: Merritt R. Nelson and Herbert H. McDonald, U. of A.

Fourteen different fungicidal treatments were made on lettuce in a replicated test of their effectiveness in controlling downy mildew. The fungicidal materials that controlled mildew best were: *zinc coposil-captan, 2 pounds each per acre; * copper sulfate, 4 pounds per acre; *zinc sulfate, 4 lbs./A.; phaltan, 2 pounds per acre; *phaltan zinc coposil, 6 pounds per acre; zineb 6 percent dust at 30 to 40 pounds per acre; and *zinc coposil, 4 pounds per acre. Fungicide formulations of inter-mediate effectiveness against mildew include: phaltan, 4 pounds per acre; karathane, .75 percent dust, 30 to 40 pounds per acre; phaltan, 2 pounds per acre (weekly) and phaltan, 2 pounds per acre. Materials giving only poor control of mildew include: captan, 2 pounds per acre; phaltan, 1 pound per acre; and phaltan 5 percent dust at 30 to 40 pounds per acre. All materials were applied bi-weekly unless otherwise indicated. Spray applications were generally better than dusting and bi-weekly treatments were as good as the weekly application.

* Spreader sticker added.

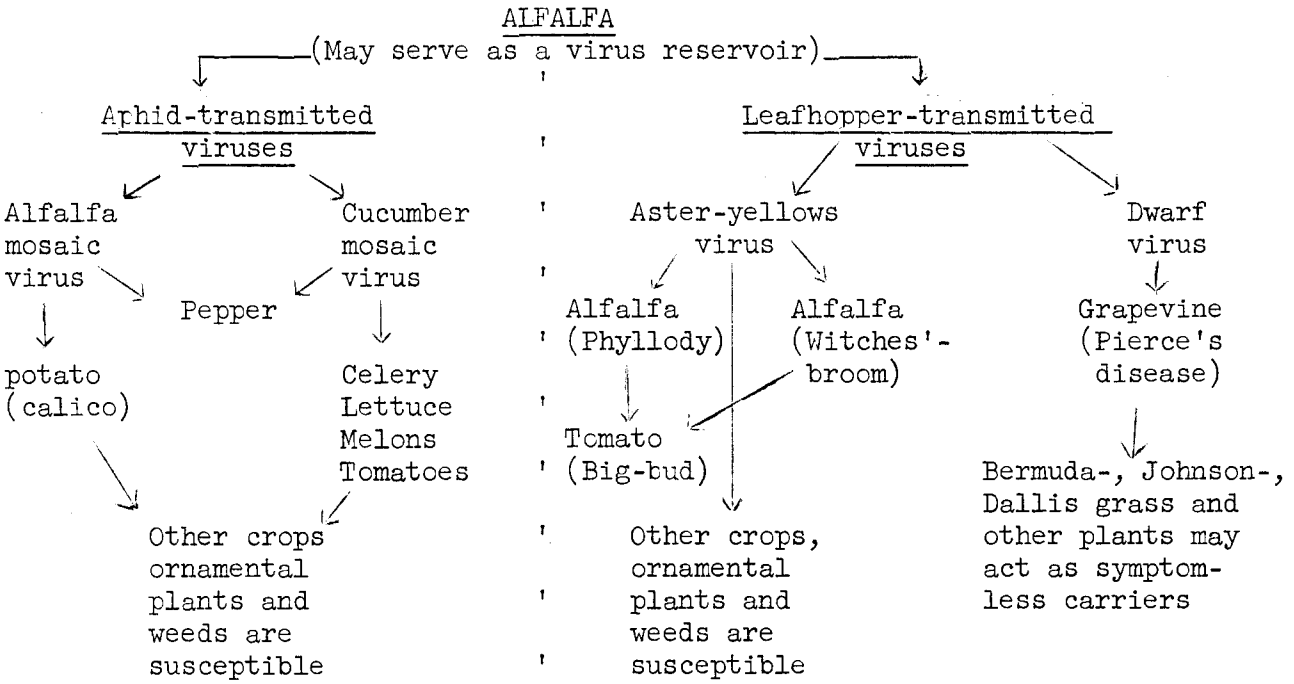
14. INTERRELATIONSHIPS OF MOSAICS AND SIMILAR VIRUSES AFFECTING VEGETABLES AND OTHER PLANTS IN ARIZONA.

Project Number: 478. Funds: Hatch and State. Personnel: Paul D. Keener.

Mosaic viruses: Cucumber mosaic virus strains were the dominant types isolated from crop plants and weeds during the past year. A strain of cucumber mosaic virus 1 (Marmor cucumeris Holmes) decreased the yield in a 20-acre stand of cantaloupes by 45 per cent. This virus did not cause the usual crown-blight symptoms but was of the type causing intense yellow leaf mottle. The vector of this strain was possibly Aphis maidis which was rather abundant for a time in the area. Other cucumber mosaic virus strains were isolated from cantaloupes from the Salt River Valley and from watermelons near Tolleson. In addition, certain accessions in the alfalfa root disease resistance program were attacked by cucumber mosaic viruses.

The pepper strain of potato calico virus was isolated from alfalfa from Mesa. This in addition to the celery strain of cucumber mosaic virus, indicates that the host ranges for such viruses are rather extensive in the State.

The ranges and relationships of some of the viruses known (through experimental procedures) to exist in alfalfas in Arizona, may be briefly diagramed as shown:



Alfalfa may also be carrier of curly-top virus.

Tomatoes from local retail markets were studied for virus contents and in approximately 90 per cent of the fruits either cucumber mosaic or tobacco mosaic viruses alone or in combinations were isolated. In one instance, yellow ringspot strain of tobacco mosaic virus was isolated from fruits which were unsightly because of numerous yellow ring-spots on the surface.

An unidentified (special breeding stock) tomato grown in a greenhouse in Yuma, was infected by one of the virulent cucumber mosaic virus strains.

Curly-top: Certain amendments added to tomato plants either by soil applications or sprayings afforded some basis for comparison of their effects on symptoms of curly-top. A standard variety used in commercial production (Early Pak) formed the basis for this study. The work was performed in cooperation with the Department of Chemistry and Soils.

No differences in severity of symptoms were noted (as expressed in necrosis of the internal and external phloems) during the course of this Experiment.

Other viruses: By far the most severe virus infections during the year were those occurring in fields of potatoes in the Queen Creek and Mesa areas. At Queen Creek, virus Y (veinal necrosis strain) was isolated from commercially-planted Pontiac. From Sonchus asper and Physalis sp. in the same area, veinal necrosis strain of virus Y, ringspot and what appears to be tobacco rosette or rattle virus, were isolated. Further studies with the potato isolations are in progress.

Virus Y, necrotic ring strain was also recovered from potato plants at the Experiment Station, Mesa.

Cucumber mosaic was isolated from Bliss Triumph plants.

Viruses consisting of strains of alfalfa mosaic (Marmor medicaginis) and cucumber mosaics were isolated consistently from alfalfas at Mesa and some materials originating at Yuma. In some areas, numerous plants exhibited virus-like symptoms.

Some 75 varieties of Sorghums in a planting at the Mesa Experiment Station, were studied for their virus vs. head smut reactions. In many cases both smut and cucumber mosaic viruses were present simultaneously in the same plants. This experiment will be continued. Virus reactions consisted of elongated chlorotic (yellow) streaks in leaves, small puckered, pimple-like leaf distortions and in several cases, severe stunting with phyllody and no seed production.

15. FUNGI OF ARIZONA.

Funds: Grant-in-aid funds from (a) The American Academy of Arts and Sciences (b) The Grand Canyon Natural History Association and (c) The Society of the Sigma Xi. Personnel: Paul D. Keener.

Various records of fungi found throughout the State were made during 1959. In many instances, specimens were cured and placed in the Phytopathological Herbarium, being developed in the Department of Plant Pathology, at Tucson. Among the interesting materials were:

Epiphytotics

(a) Peach and Apricot Shot-hole disease (caused by the fungus, Coryneum beijerinckii Oud.).

On Rio Oso Gem peaches in the Sedona area, this disease was so prevalent in some orchards, even on fruits that the product was unmarketable. Twigs of the infected trees also showed the typical "shot-hole" lesions.

In 1942 a previous record of this disease was made on unidentified varieties of peaches from Cochise County.

In 1951, apricots sent in from the Oak Creek area (Sedona, etc.) showed lesions on both twigs and fruits. The disorder went unrecognized at that time.

(b) Phacidium blight on needles of Western Yellow Pine (Pinus ponderosa Laws.).

Rather severe on trees in the Prescott National Forest, in Crook Canyon, Hassayampa Lake, and Groom Creek near Prescott, Yavapai County.

Discussed more fully in another section.

(c) Coryneum cinereum blight on needles of Western Yellow Pine (Pinus ponderosa Laws).

Limited but serious outbreak on North Rim of the Grand Canyon, Grand Canyon, National Park, Coconino County, Arizona.

Herbarium specimens of special interest	Host plant or other substrata
Astraeus hygrometricus (Pers.) Morgan Earth Star	Ground
Bifusella abietis Dearn. Needle-cast	Abies lasiocarpa (Hook) Nutt.
Boletus elegans Mycorrhizal assoc.	Conifer forest
Boletus granulatus Mycorrhizal assoc.	Conifer forest
Cantharellus cibarius Fries	Ground
Cantharellus floccosus Schweinitz	Ground
Cenangium ferruginosum Fr. Canker	Pinus ponderosa Laws.
Chrysomyxa pirolata Wint. Rust	Pyrola virens Schweigg.

Citractia caricis (Pers.) Magn. Smut	Carex siccata Dewey
Clavaria purpurea Fries Club Fungus	Ground
Coryneum cinereum Dearn. Needle-blight	Pinus ponderosa Laws.
Crucibulum vulgare Tul.	Ground
Crypotochaete rufa (Fr.) Karst. Stem canker	Populus tremuloides Michx.
Cumminsiella mirabilissima (PK.) Nannf. Rust	Mahonia repens (Lindl.) Don
Cyathus striatus (Willd.) Pers.	Ground
Darluca filum (Biv.) Castagne Rust parasite	Uromyces intricatus Cke on Erigonum racemosum Nutt.
Darluca filum (Biv.) Castagne Rust parasite	Coleosporium crowellii Cummins on Pinus edulis Engelm.
Darluca filum (Biv.) Castagne Rust parasite	Coleosporium jonesii (PK.) Arth. on Ribes inebrians Lindl.
Echinodontium tinctorium Indian Paint Fungus	Abies concolor (Gordon & Glendinning) Hoopes
Elytroderma deformans (Weir) Darker Needle-cast	Pinus ponderosa Laws.
Elytroderma deformans (Weir) Darker Needle-cast	Pinus edulis Engelm.
Epicoccum purpurascens Ehrenb. Leaf fungus	Lupinus argenteus Pursh
Erysiphe cichoracearum DC. Powdery Mildew	Gutierrezia sarothrae (Pursh) Britton & Rusby
Erysiphe cichoracearum DC. Powdery Mildew	Lactuca serriola L.
Erysiphe polygoni DC. Powdery Mildew	Polygonum aviculare L.
Fomes cajanderi Karst. Wood rot	Pseudotsuga Menziesii (Mirb) Franco
Fomes fraxinophilus (Peck) Cke. Wood rot	Fraxinus velutina Torr.
Fomes igniarius (L. ex Fr.) Kickx. Wood rot	Populus tremuloides Michx.
Fomes officinalis (Vill. ex Fr.)Faull. Wood rot	Pinus ponderosa Laws.
Fomes pini (Thore ex Fr.) Karst. Wood rot	Abies concolor (Gordon & Glendinning) Hoopes
Fomes pincola (Swartz ex Fr.) Cke. Wood rot	Pinus ponderosa Laws.
Fomes pinicola (Swartz ex Fr.) Cke. Wood rot	Pseudotsuga Menziesii (Mirb) Franco

Fomes robiniae (Murr.) Sacc. & D. Sacc. Wood rot	Robinia neomexicana Gray
Fomes unitus (Pers.) Lowe Wood rot	Pinus ponderosa Laws.
Ganoderma sp. Wood rot	Eriobotrya japonica (Thunb.) Lindl. (LOQUAT)
Gymnosporangium multiporum Kern Rust	Juniperus monosperma (Engelm.) Sarg.
Gymnosporangium speciosum Pk. Rust	Juniperus deppeana Steud.
Gymnosporangium nelsoni Arth. Rust	Amelanchier Goldmanii Woot. & Standl.
Hydnum auriscalpium Fr.	Cones of Pseudotsuga Menziesii (Mirb.) Franco
Hydnum erinaceus Bull. Wood rot	Platanus Wrightii Wats.
Hydnum imbricatum L. ex S. F. Gray	Ground
Hydnum repandum Fr.	Ground
Hydnum suaveolens Fr.	Ground
Hygrophorus purpurascens (A. & S. ex Fr.) Fr.	Ground
Hypoderma pini (Dearn.) Darker Needle-cast	Pinus edulis Engelm.
Hypodermella abietis-concoloris (Mayr.) Dearness Needle-cast	Abies concolor (Gordon & Glendinning) Hoopes
Hypodermella concolor (Dearn.) Darker Needle-cast	Pinus ponderosa Laws.
Hypodermella medusa Dearn Needle-cast	Pinus ponderosa Laws.
Hypomyces lactifluorum (Schw.) Tul.	Parasitizing a fleshy fungus of the genus Lactarius
Hypospila californica Dearn. & Barth. Leaf spot	Alnus oblongifolia Torr.
Lasiobotrys symphoricarpi Tar- Leafspot	Symphoricarpos sp.
Melampsora albertensis Rust	Populus tremuloides Michx.
Phleospora robiniae (Lib.) Hoeh. Leafspot	Robinia neomexicana A. Gray
Phyllosticta sp. Leafspot	Cercis occidentalis Torr.
Phyllosticta sp. Leafspot	Populus Fremontii Wats.
Phyllosticta sp. Leafspot	Acer glabrum Torr.
Peridermium ephedrae Cke. Rust	Ephedra sp.
Puccinia cynodontis Lacroix ex Desm. Rust	Cynodon dactylon (L.) Pers. (Bermuda Grass)

Puccinia pulverulenta Grev. Rust	Gayophytum Nuttallii Torr. & Gray
Pucciniastrum agrimoniae (Diet.) Tranz. Rust	Agrimonia grysosepala Wallr.
Sphacelotheca cruenta Loose Kernel Smut	Sorghum, Pop (in experimental plots at Mesa Station)
Stropharia semiglobata (Fr.) Quel. var. stercoraria	Dung
Trabutia erythrospora (Berk & Curt.) Thiess & Sydow Leafspot	Quercus sp.
Tremellodon gelatinosum Fr.	On decaying conifer wood
Uromyces intricatus Cke. Rust	Eriogonum racemosum Nutt.

Some 200 specimens mostly from the rust collections of the late W. H. Long were donated to the Department by the United States Department of Agriculture, Forest Service, Forest Disease Laboratory, Albuquerque, New Mexico. These will make a fine addition to the Cryptogamic Herbarium.

16. COTTON DISEASES IN ARIZONA.

Funds: State. Personnel: Ross M. Allen and H. H. McDonald, U. of A.

Six fungicidal dusts were applied to seed furrows as Arizona 44-WR seed were planted in a replicated test on March 19, 1959. Statistical analysis showed no real differences for treatments in controlling seedling diseases. Very little post-emergence damping-off occurred in the test plots. A second test included 14 fungicidal seed treatments. Significantly different percentages of emergence were found for Captan 75-W, Hercules 3944, Chipcote 25, PCNB plus Captan, and PCNB plus Ceresan. Leaf Crumple studies indicate that this disease will not be a problem where stubbed cotton is eliminated. A paper has been submitted to Plant Disease Reporter giving results of previous studies. Boll rot work shows greatest numbers of boll rots occur in August and are sharply reduced in September. Most boll rots followed insect injury. Yellow lint stain incidence was slight.

17. DISEASES OF SAFFLOWER.

Personnel: Ross M. Allen, and H. H. McDonald, U. of A.

Recently intensified interest in safflower production in the Yuma area resulted in limited studies of two diseases of this crop: rust and a new, unidentified virus disease. Uredospores of rust failed to survive a Yuma summer when stored in cloth sacks on the side of a lath-house. The telial stage will survive oversummer in the field when safflower succeeds safflower after an intervening fallow period. Field plots have been organized to test methods of eliminating this oversummering stage. The cause of the new virus disease has been identified as cucumber mosaic through differential host studies, temperature inactivation series and dilution series. The virus is easily transmitted from safflower to safflower by standard mechanical methods. Insect transmission and cross protection tests have been initiated.

18. CONTROL OF LETTUCE BIG VEIN.

Funds: State. Personnel: R. B. Marlatt, R. T. McKittrick.

Soil Fungicides

Five soil fungicides were evaluated in a field experiment consisting of seven treatments replicated four times. Soil treatments included per-acre applications of calcium cyanamide - 1000 lbs.; chloropicrin - 35.5 gal.;D-D 20 gal. and 60 gal.; PCNB, 75% wettable powder, 150 lbs. active ingredient; Vapam, 31% mixed with an equal amount of water, 60 gal.

None of the treatments resulted in significantly less big vein than the control. A root rot which attended salt injury was apparently controlled best by D-D. The rate of 20 gal. D-D per acre showed significantly better stands than the controls.

Irrigation

To note the effects of varying amounts of water upon big vein incidence, big vein was recorded in a lettuce irrigation experiment. Three irrigation treatments consisted of: Dry -- irrometer reading 75 to 80, Medium -- 35 to 40, and Wet -- 18 to 20. Total plants in two center beds of each plot were counted and the percentage with big vein were calculated.

Analysis showed no significant differences in amounts of big vein despite the great differences in soil moisture.

Crop Rotation

The percentages of plants with big-vein symptoms were calculated for a crop-rotation experiment. The rotation began in 1955 and included papago peas - melons - lettuce, steer manure - melons - lettuce, alfalfa - melons - lettuce, guar - lettuce-melons, and melons - lettuce as control.

The manure rotation contained significantly more big vein, probably because lettuce in manured plots grew faster and developed more during temperatures most conducive to big-vein infection and symptom expression. None of the crop rotations resulted in less big vein than the melon-lettuce control.

Leaf Zinc Content

In a previous experiment application of zinc to lettuce appeared to reduce big vein. Therefore, normal lettuce and plants showing big vein were collected and leaves were analyzed for zinc by G. C. Sharples, Horticulture Department. Zinc contents varied from 7.4 to 16.5 ppm. There appeared to be no correlation of leaf zinc content with big vein.

Big Vein In Desert Soil

Lettuce plants were collected near Aguila in a field which was claimed to be virgin desert immediately before the lettuce crop. Pieces of root epidermis from healthy and big vein plants were examined microscopically. An Olpidium fungus was found in only two of the 48 epidermis specimens from healthy plants. In an equal number of big-vein specimens, 26 were found to contain Olpidium. The causal organism appeared to occur in reputedly virgin desert soil.

19. THE CAUSE AND CONTROL OF LETTUCE INTERNAL STEM DISCOLORATION.

Funds: State. Personnel: R. B. Marlatt, R. T. McKittrick.

Bacterial Inoculations

Lettuce specimens were received in late October from variety trials at Kansas Settlement near Willcox. Some nearly mature plants were wilting. In cutting longi-sections, the stem pith was found to be watersoaked and brown, often with a red vascular ring and sometimes hollow where the stem pith joined the root.

Four bacteria and a fungus were recovered by culturing diseased stems. These organisms were used for inoculating greenhouse lettuce. Some plant stems were periodically inoculated with a needle, others received inoculum around their roots; all treatments were replicated four times. Lettuce was grown to mature heads, split, and examined for internal stem discoloration.

One bacterium caused a significantly higher discoloration rating (0 to 5) when injected into the stem than the broth-injected control. However, the discoloration was slight as compared to the field disease and the pith did not become hollow. No disease resulted from soil inoculation.

Soil Transmission

Soil from a field containing diseased lettuce was transported to Mesa, half of it steam pasteurized, and all of it potted for greenhouse lettuce. Roots were injured with a knife in some of the pasteurized and control pots to stimulate root infection.

After splitting mature heads practically no stem or root discoloration was found in any plants grown in Kansas Settlement soil.

Inoculations With Stem Tissue

A slightly different discoloration was found near Yuma in the Gila Valley and in Deer Valley near Phoenix. Vascular areas of the stem were blackened and cavities were found in the stem pith containing brown, solidified latex. When cut, the stem exuded copious amounts of latex and solidified latex was found on heart leaves. Non-septate, intercellular, hyaline mycelium was found in the stem pith adjoining the brown cavities. Hyphae penetrated adjoining cells and what first appeared to be haustoria enlarged and developed into thick-walled spores, which looked like oospores.

Diseased stems were disinfected, pared, macerated in a Waring Blendor and poured onto lettuce plants in the greenhouse. Plants were kept at 100% relative humidity and at temperatures favorable for downy mildew infection and sporulation for two weeks. During following weeks temperatures were probably above these optima during the day. No fungus infections were found when plants were examined.

Surface-disinfected, pared, diseased stems were incubated at 100% relative humidity and 55° F and others were cultured on water agar but the fungus would not sporulate or grow out of the stems.

Department of
POULTRY SCIENCE

1. ESTABLISHING A HEAT RESISTANT STRAIN OF WHITE LEGHORNS.

Project Number: 363. Funds: Hatch and State. Personnel: H. B. Hinds, M. W. Pasvogel, A. A. Kurnick.

Line	Winter Prod. %	Summer Prod. %	Total Prod. %	Feed Lbs/ doz.	Body Wt. gms.
55	65.2	59.5	62.6	4.29	1627
553	80.6	67.0	74.0	3.95	1824
551	54.2	42.0	47.8	5.57	2127
552	64.6	70.5	67.4	4.40	1940

A slight improvement in the rates of total summer egg production over the previous year was noted in lines 55 and 553, the strains containing the lighter bodied hens. The average body weights of these birds have declined by 350 and 277 gms. respectively, from those noted during the fourth laying year. Improved egg production and the decline in average weight was accompanied by an improvement in feed conversion of 0.20 and 0.55 lbs. of feed per dozen eggs.

2. THE UTILIZATION OF ARIZONA CROPS IN CHICKS' DIETS.

Project Number: 364. Funds: Hatch and State. Personnel: A. A. Kurnick.

A basal diet for broiler chicks consisting of milo, cottonseed meal, dehydrated alfalfa meal, meat and bone scraps, sesame oil meal, and fish meal was supplemented with l-lysine HCl at levels of 0.1 to 0.5% of the diet. The diets were fed to 12 lots of crossbreed (Arbor AcresX White Ventress) day-old chicks. Each lot (treatment) was replicated ten times (5 males and 5 females) with 25 birds per replicate.

Maximum growth rate of male and female chicks was obtained at the 0.3% level of supplementation; corresponding to a total lysine level of 1.14% by analysis. The basal ration, containing 0.9% lysine, was improved markedly; chicks fed the basal diet weighed 368 gms. at 6 weeks of age as compared to 760 gm. average weight for chicks fed the supplemented diet (0.3% added lysine).

3. THE ROLE OF EGG CARTON LABELING IN THE RETAIL MARKETING OF EGGS.

Project Number: 469. Funds: Hatch and State. Personnel: G. R. Powell, A. A. Kurnick, R. E. Seltzer, F. D. Rollins.

Open displays of 3 to 6 rows of cartoned eggs, all carying the same brand, were prepared in a local supermarket. During the course of each 3-day trial period equal rows were assigned to the cartons that were labeled as shown below and arranged so that they were equally accessible to the consumer for selection. Daily beginning and ending inventories of each type of carton were taken, and the sales tabulated as follows:

Type of printing	1st. period Cartons sold %	2nd. period Cartons sold %	Total Cartons sold %
None	31.97	13.69	30.27
Blank label	31.05	40.22	31.91
Label with printing*	36.97	46.08	37.63

*Text of label: "Two eggs contain 17.4% of the minimum daily protein requirement for adults."

4. UTILIZATION OF DIETARY ENERGY BY LAYING PULLETS DURING DIFFERENT SEASONS.

Funds: State. Personnel: A. A. Kurnick, H. B. Hinds.

Studies have been initiated to evaluate the effects of dietary energy levels on laying strain pullets as affected by the environmental temperature and the season during which sexual maturity occurs.

The first two phases of this study have been completed. Using energy levels of 965, 865, and 765 Cal./lb., birds which matured in October, 1958, exhibited a higher rate of lay on the 965 and 865 Cal. diets during the winter months (November through February) than those fed the 765 Cal. diet. Summer production appeared to be slightly better on the lowest energy level.

The second phase involved birds which matured in February, 1959. Egg production declined quite rapidly after 4 months of production (June). In this portion of the study the higher energy levels (965 and 865 Cal./lb) maintained better summer production than did the 765 Cal. level.

5. UTILIZATION OF YOLK-SAC CALCIUM AND PHOSPHORUS BY THE NEWLY HATCHED CHICK.

Funds: Grant-in-aid. Personnel: T. A. Crowley, A. A. Kurnick, M. G. Vavich, and A. R. Kemmerer. (In cooperation with the Department of Biochemistry).

Utilization of yolk-sac Ca and P by newly hatched chicks between 19th and 21st day of incubation was determined. Newly hatched chicks were counted at 6-hour intervals. Half of the chicks were removed from incubator, weighed, sacrificed, and the yolk-sac removed. Yolk-sac and carcasses (entire chick except yolk-sac) were analyzed for Ca and P. Remaining chicks were left in incubator until end of the incubation period. Half the chicks removed from incubator on 22nd day were sacrificed and treated similarly to those described above. Remaining chicks were placed on a cerelose-blood fibrin diet containing .031% Ca and .06% P. Carcasses and yolk material of chicks hatched at various 6-hour intervals contained Ca and P concentrations. Yolk-sac Ca:P of newly hatched chicks ranged from 2.43 to 2.95 mg., while that of corresponding carcasses ranged from 1.27 to 1.37 mg. After 21 days of incubation, Ca:P of yolk-sac and carcasses ranged from 7.76 to 2.63 mg. and 1.79 to 1.33 mg., respectively. This indicated a greater rate of P than Ca transfer from yolk to chick and a greater loss of P than Ca from chick into excreta. Survival on deficient diet averaged 9 days. Analyses of dead chicks indicated a greater retention of P than Ca, opposite of that noted during incubation.

6. ABSOLUTE SODIUM AND HALIDE DEFICIENCIES.

Project Number: A-2274. Funds: Grant from United States Public Health Service. Personnel: A. A. Kurnick, E. B. Kurtz, A. R. Kemmerer, E. C. Brodie. (In cooperation with the Departments of Agricultural Biochemistry and Botany, and United States Public Health Service.)

The following has been accomplished in the growing of soybeans and sorghum, using hydroponic techniques in order to eliminate fluorine from the plant: (a) A greenhouse has been constructed "dust free" and temperature controlled; (b) Silica sand (8000 lbs.) has been treated with acid and heat to volatize any fluorine present. Analyses have shown the sand to be fluorine free; (c) A water system was developed to produce water of 16-18 meg. ohms resistance; (d) The soybean and sorghum seeds planted in January were found to contain 4.2 and 0.4 ppm of fluorine respectively; (e) The salts used for the culture media were recrystallized. No fluorine could be detected in the individual salts or in the prepared nutrient solution; (f) Effluent collected from the plastic baskets where the plants are being grown was concentrated 25 times and analyzed for fluorine. Results indicated the absence of this element in the above effluent.

Institute of
WATER UTILIZATION

1. REDUCTION OF EVAPORATION LOSES BY USING MONOMOLECULAR FILMS.

Project Number: 507. Funds: State. Personnel: S. D. Resnick, Project Leader; K. J. DeCook; G. Maddox; H. Waldon and E. Bury.

Records were obtained on duplicate pairs of Class A evaporation pans, one pan being treated with hexadecanol and the other pair left as a check. About 60% of the water normally lost to evaporation was saved by using the hexadecanol. Temperature records indicate that the treated pan was as much as 10° F warmer than the untreated.

A device was developed that could be used to dispense the hexadecanol. It consists of a screened compartment with attached floats. The powdered hexadecanol is placed in the compartment where it is supposed to dissolve and form a film. There was some difficulty with algae formation inhibiting the spreading of the film.

One of two stock watering tanks on a local ranch was treated with hexadecanol. Inflow, outflow records were obtained with domestic type water meters. Due to malfunction of several of the five meters, no conclusive data was obtained.

2. SELECTION AND TESTING OF MATERIALS FOR SURFACING WATERSHED AREAS.

Project Number: 508. Funds: State. Personnel: Jim DeCook, George Maddox, Sol Resnick.

Conversion of three acres of ungraded land to a more uniform grade occupied the majority of the working season this year. Literature survey and other background work was continued. Several alternate experimental designs and types of equipment were evaluated in an attempt to find the best layout for minimum expenditure of funds. Several chemical companies were contacted to learn if they had any chemicals that could be used on this project.

3. INVESTIGATION OF SITES, METHODS, AQUIFER DETERIORATION CONTROL, AND EFFECTS OF ARTIFICIAL GROUND WATER RECHARGE OF ALLUVIAL-BASINS TYPICAL OF THE ARID SOUTHWEST UNITED STATES.

Funds: State. Personnel: George E. Maddox, S. D. Resnick, One-half Time Graduate Assistant.

A ground water recharge test was carried out at Litchfield Park, Arizona, in an effort to determine the feasibility of recharging sediment laden tail-water from irrigation. The preliminary test entailed flocculation of 100,000 gallons of turbid tail-water, and injection of the treated and clear water down an old irrigation well. Results show the limited recharge test was successful in that an effective field method of treating the tail-water at the recharge locale was established, and coefficients of transmissibility and storage of the aquifer were calculated.

Laboratory experiments have shown the importance of proper agitation to bring about maximum water clarification by means of various types of commercial flocculating agents. Different methods of instrumentation were studied, and a series of instruments adopted or designed which will give accurate readings on water clarity under field conditions. With the adopted instrumentation and field test procedures developed from laboratory experiments, studies of the action of flocculating agents under natural conditions are now possible.

Investigation of subsurface stratigraphic controls of ground water along Rillito Creek, near Tucson, Arizona, has shown areas where artificial ground water recharge may be employed as a method to efficiently and beneficially use runoff from precipitation and add materially to the water supply of the City of Tucson.

Department of
WATERSHED MANAGEMENT

1. THE RANGE RESOURCES OF ARIZONA.

Project Number: 232. Funds: Hatch and State. Personnel: R. R. Humphrey.

Work previously begun on Pima, Pinal and Santa Cruz Counties has been completed. The manuscript is in the hands of the Station editor. Vegetation maps of these counties have been prepared and cuts for color reproduction have been made. The data that have been collected and written up include (1) range forage type descriptions, (2) range condition analyses on each type and on sites within types, (3) Photographs of the various types and condition clones, (4) a statement of the forage value and a line drawing of each forage species mentioned in the text, and (5) a statement of the range-management practices required for range improvement or maintenance.

2. CONTROL OF NOXIOUS SHRUBS ON SOUTHWESTERN RANGES.

Project Number: 285. Funds: Hatch and State. Personnel: E. M. Schmutz, R. F. Wagle.

CHOLLA AND PRICKLY PEAR CACTUS

Readings on cholla sprouts following chopping confirm the two periods, October-December and May-June, as the best months for mechanical treatment of cholla. Sprouts established during these periods varied from 200-300 per acre, approximately the same density as originally. Highest sprouting occurred when chopping was done in the periods, February-April and July-August. Sprouts during these periods were initially as high as 6,000 to 7,000 per acre but, after three years, natural death had reduced these numbers to between 300 and 700 established plants per acre.

BURROWEED

Reactivation of this study is pending receipt of additional funds.

OAK CHAPARRAL

Results of two-consecutive-year airplane applications of 1 2/3# per acre of 2,4,5-T herbicides on turbinella oak resulted in 10-30% total kill as compared to 0-8% kill from a single application. Hand spray applications to individual plants resulted in 8-20% kill from a single-year one-pound application and 40-65% kill from two-consecutive-year one-pound applications. Preliminary results from tests with monuron, PBA and fenuron indicate promise at heavy rates.

CREOSOTEBUSH, TARBUSH AND WHITETHORN

The 1958 tests with both 2,4-D and 2,4,5-T resulted in unusually high, 90-100%, kill on all three shrubs at the 2 and 8# rates, showing marked year to year variation. Even the 1/2# rate test gave 80% kill on resistant creosotebush. Granular herbicides, monuron and PBA, gave 40-70% kill at the 8# rate but less than 10% at the 2# rate. Radioisotope studies on creosotebush showed an expected close correlation between seasonal absorption-translocation and percent kill.

3. SHRUB INVASION - FORAGE PRODUCTION INTERRELATIONS ON ARIZONA RANGELANDS.

Project Number: 292. Funds: Hatch and State. Personnel: D. G. Wilson.

Phase I: Final species composition and density measurements were completed in September and forage production determined in October. Perennial grass production was greater on all plots including the untreated; however from preliminary examination of the data, only the production on the completely cleared plots appears to be significant.

Phase III: Soil separate analyses were completed. Chemical analyses involving pH, total soluble salts, nitrate, phosphate, organic matter and calcium carbonate were also determined. Data are being statistically analyzed. Species composition of perennial grasses and total crown intercept of shrubs and trees was determined on all plots.

4. POISONOUS PLANTS OF ARIZONA.

Project Number: 328. Funds: State. Personnel: D. G. Wilson.

None. Time restrictions on the investigator precluded any field work. A limited amount of manuscript preparation was accomplished.

5. SURFACED RUNOFF BASIS AS A SOURCE OF STOCKWATER ON SEMIARID RANGES.

Project Number: 330. Funds: State. Personnel: R. R. Humphrey, R. M. Turner, R. J. Shaw, E. M. Schmutz.

The construction of certain low-cost surfaced runoff areas for the collection of precipitation for watering livestock and game was found to be feasible and practical. A runoff area paved with a 2-inch layer of asphalt was found to stand up well for a period of 9 years, after which resealing was desirable. Runoff tests from the asphalt after 9 years yielded approximately 50% of rainfall from small storms, 0.15" rains; and approximately 90% of the rainfall from 1-inch storms. Two areas paved with polyvinyl plastic deteriorated to complete uselessness after 2 years. However, the first year the plastic recovered approximately 80% of the runoff from small, 0.15" storms.

6. CHANGES IN THE DESERT GRASSLAND - AN ANALYSIS OF CAUSES.

Project Number: 365 (W-25). Funds: Regional Research and State. Personnel: R. R. Humphrey, Joel Verner, Patrick Dalton.

Work is continuing on an ecological study of creosotebush. The objectives are to determine past and present distribution, degree of invasion of the desert grassland and the factors affecting spread of this shrub into grassland areas. Seeds germinate under a wide range of temperature, light and pH. Vegetative growth and fruiting are correlated with soil moisture. Flowering as a response is more immediate than leaf and stem production. Leaf-moisture contents range from 25% during drought to 59% during the rainy season. The plants generally sprout from the base after burning. Root development is correlated with availability of moisture.

The ecology of Tobosa grass is being studied as a second phase of this project. Three kinds of sites are being studied: (1) lowland swales, (2) hillsides in a desert-shrub type, and (3) level plateaus with little other vegetation. Soil moisture determinations on a swale-type site are made at weekly to bi-weekly intervals. Moisture analyses are being made at 1", 6", 12" and 18" depths in the tobosa stands and on adjacent non-grassed areas to correlate soil moisture with occurrence of tobosa. Final analyses of these data are not yet available.

7. SEED INCREASE AND PRELIMINARY EVALUATION OF PLANT INTRODUCTIONS THAT MAY BE SUITED TO THE SOUTHWEST.

Project Number: 368 (W-6). Funds: Regional Research and State. Personnel: L. P. Hamilton and D. G. Wilson.

During the 1958-59 growing season, 53 lines of grasses, 86 lines of legumes and seven lines of miscellaneous species were under test. Two hundred and fourteen lines of grasses and 63 lines of legumes were grown for seed increase.

Promising Lines

Astragalus armeniacus P.I. 214,095, Astragalus mexicanus P.I. 214,097 and Astragalus stipulatus P.I. 214,101 made vigorous growth and survived the summer heat. They appear similar to Astragalus cicer which has proved promising for high elevation seedings.

Eragrostis curvula P.I. 232,831 is a vigorous growing number surpassing the previous standard for leafiness. It has a rapid recovery after clipping in the late summer.

Eragrostis superba P.I. 145,879 proved to be the same introduction which was increased and released for certification by the Arizona Agricultural Experiment Station and former Soil Conservation Nursery.

One number of Smilo grass, Oryzopsis miliacea P.I. 234,483 retains green leaves and stems into maturity and may offer later range production than other numbers.

Phalaris tuberosa, P.I. 202,480 and P.I. 240,249, both from Morocco, have proved the earliest grasses to produce forage in the spring that the Center has tested. The Center has taken over P.I. 202,480 and is determining its growth curve through the season and making clonal selections for earliness.

8. ECOLOGICAL EFFECTS OF FERTILIZERS ON DRYLAND RANGES.

Project Number: 424. Funds: State. Personnel: D. G. Wilson.

Observations and measurements were made to determine residual effects of fertilization on two study areas treated in 1958 on the Santa Rita Experimental Range. Data on color, regrowth following over-utilization, relative height growth, time of flowering and seed set was secured. Preliminary evaluation of this data indicates no difference in the factors measured or observed.

It was noted that species composition changes occurred on the Holt study plots due to very heavy utilization of the relatively small plots. Annual grasses were more prevalent on the plots fertilized at the higher rates. In addition many of the individual marked plants of Arizona cottontop on the Tixier study did not survive the clipping to 3" stubble height. However, no definite pattern in regard to fertilizer treatment was noted. Because of the above factors, no attempt was made to determine seasonal forage production.

9. DRYLAND LEGUMES FOR SOUTHWESTERN RANGELANDS.

Project Number: 425. Funds: State. Personnel: D. G. Wilson.

Observational notes were taken on the 1955, 1957 and 1958 plantings. One planting of 230 plants set out in the summer of 1955 survives. The previously reported Afghanistan introduction (P.I. 211,607) initiated regrowth in the early spring of 1959, but failed during the summer.

Four plants (2P.I. 211,607, P.I. 170,446 and P.I. 212,858) of the 150 transplants of 1957 remain. The winter planting of 1958 was a complete failure.

Four plants of a total of 310 representing 35 P.I. introductions set out in March, 1959, survive. All plants survived the transplant from greenhouse to field, but the majority failed to show any regrowth when checked in July after the onset of summer rains.

10. RESEEDING OF ARIZONA RANGES.

Project Number: 470. Funds: State. Personnel: D. G. Wilson and L. P. Hamilton.

A dryland test site was established on the Ted Smith Farm at Linden. Various species and accessions of Agropyron and Bromus are being investigated for possible use on the problem areas in the pinyon-juniper and coniferous forest zones.

A replicated rod-row planting was set out on the ranch in the vicinity of Holbrook. Lines or varieties of galleta, Caucasian bluestem, Turkestan bluestem, blue grama,sideoats grama and Boer lovegrass are being tested.

Two outstanding lines of Boer lovegrass (A-84 and A-12752) were set out in replicated plantings on the Ogurek Ranch in Cochise County. This species appears to be superior to others tested in the desert grassland area.

11. GROWTH VARIATION IN QUERCUS TURBINELLA, GREENE, AND ITS RELATION TO ENVIRONMENT.

Project Number: 486 (W-63). Funds: Regional Research and State. Personnel: Robert F. Wagle, Project Leader, David Whitham, Graduate Assistant.

Soil environment studies have been emphasized in the Arizona project. Soil bioassays, using lettuce indicator plants, have been completed on 15 soils. Chemical and mechanical assays have been completed on 15 soils from the geographic range of chaparral. The soils studied have exhibited the following characteristics:

(a) Soil texture in general was coarse.
(b) Chemical and bioassay results compared favorably on soil nitrogen content, but differed greatly as an index for available soil phosphate.
(c) Certain vegetation soil relationships were indicated. Grass areas exhibited nitrogen deficiencies, but no phosphate deficiencies. Soil from shrub-covered areas showed nitrogen deficiencies in five of ten samples. The nitrogen deficiencies were associated with a high Ca CO_3 content. Soil samples from woodland areas (ponderosa pine) showed no nitrogen deficiencies, but had phosphate deficiencies.

Herbicide: Quercus turbinella plants were broadcast treated in the winter with five different rates of fenuron in a burned over area and in an unburned area. Preliminary observations indicate 90% of the plants were affected in the unburned area at 8 pounds per acre. Rates of 16 pounds per acre affected most sprouting plants on the burned over area.

Germination Results: Very little germination work was carried out this last year due to a poor seed crop.

12. MANAGEMENT OF SECOND-GROWTH PONDEROSA PINE.

Forestry Project. Funds: State. Personnel: A. L. McComb, Philip Knorr, Robert F. Wagle.

The forestry problems of Arizona have been studied to determine important areas of research falling within the capabilities and limitations of staff and budget. A decision was made to study problems relating to the management of second-growth ponderosa pine. Many forestry problems stem from the high density of the younger stands. Objectives of the research which will be conducted by three staff members of the department include: (1) the effect of stand density and thinning on growth and yield; (2) development of economic methods of thinning and stimulating stagnating pre-commercial stands; (3) determination of the relationships between prescribed burning, wildfire incidence and control and stand structure; and (4) the relationships between stand density and structure and the water cycle. Work has started on several objectives. Preliminary studies of the water balance in various parts of Arizona have been started as background for the water cycle studies. Some studies of site characteristics at the lower elevational limits of ponderosa pine have been made.

13. TRANSPIRATION STUDY.

Funds: Pack Foundation. Personnel: David R. Kincaid, R. F. Wagle (advisor).

A device suitable for measuring transpiration (consisting essentially of a plexiglass chamber equipped with an electric hygrometer) has been designed, constructed and calibrated in the laboratory. Transpiration rates of four plant species have been measured under controlled conditions of humidity and temperature.

14. ANNUAL RING STUDIES IN DESERT SHRUBS.

Project Number: G-5568. Funds: National Science Foundation. Personnel: R. R. Humphrey, C. W. Ferguson, D. P. Morris, David Goodman, J. C. Greenleaf, and G. C. Kenny.

The project continued a previous study of growth rings in big sagebrush (Artemisia tridentata) and an exploratory investigation of growth rings of woody plant species in and adjoining the desert grassland of southwestern United States and northern Mexico. Preliminary studies indicate that the woody stems of many shrubby species have definable annual growth rings. Interpretable ring chronologies have been found in service-berry (Amelanchier sp.), big sagebrush (Artemisia tridentata), netleaf hackberry (Celtis reticulata), rabbit-brush (Chrysothamnus nauseosus), two species of Mormon tea (Ephedra), bitter-brush (Purshia tridentata), and sumac (Rhus microphylla).

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December 31, 1959

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